Marine Science Affairs

—A Year of Broadened Participation

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THE THIRD REPORT OF THE PRESIDENT
TO THE CONGRESS ON MARINE RESOURCES
AND ENGINEERING DEVELOPMENT

JANUARY 1969

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—*A Year of Broadened Participation*

THE THIRD REPORT OF THE PRESIDENT TO THE CONGRESS ON MARINE RESOURCES AND ENGINEERING DEVELOPMENT

JANUARY 1969

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January 17, 1969.

To the Congress of the United States:

The sea holds new promise for the enhancement of men's lives—for economic and social betterment and for world peace and understanding.

Since enactment of the Marine Resources and Engineering Development Act three years ago, the United States has embarked on a concerted national enterprise to realize that promise. We engaged the ideas, encouraged the participation and focused the investments of our Federal Government, states, industry and universities on more effective and intelligent use of the marine environment.

We sought to:

—Enhance the many uses of our seashore and coastal waters by directing national attention to the need for skillful management of this Coastal Zone;

—Expand our knowledge of the seas by launching the International Decade of Ocean Exploration;

—Promote world order and understanding by strengthening the framework of international law and cooperation governing ocean activities;

—Foster national security by advancing the Navy's technological capabilities to operate within the ocean;

—Stimulate the economy by encouraging development of marine energy and food resources;

—Combat malnutrition in developing countries by extracting new sources of protein from the sea;

—Protect the life and property by safer maritime practices and measures to prevent pollution;

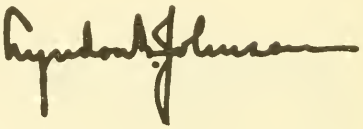
—Strengthen our base of research and education in marine sciences by supporting Sea Grant and other university programs.

While modern science and technology afford powerful means to translate marine potentialities into realities, the economic, social, legal and political considerations are equally decisive in utilizing the seas to achieve the goals and aspirations of our society. To this end, the National Council on Marine Resources and Engineering Development under chairmanship of the Vice President has illuminated goals, formulated priorities and coordinated and advanced our Federal marine policies and programs.

The Council's Third Report on Marine Science Affairs relates the sea to our people's diversified endeavors, summarizes progress during the past years and sets forth major recent accomplishments of the eleven Federal agencies engaged in marine sciences. In Fiscal Year 1970, I am requesting that $528 million be provided to build on these achievements.

The report is commended to all who look to the future for ways to reinforce our country's vitality and strength.

As our population crowds along our coast, as many nations extend their interests toward distant seas, as new scientific discoveries reveal more of the world around us, we must take bold and imaginative steps to enable this and future generations to enjoy the full bounty of the sea.



THE WHITE HOUSE

THE VICE PRESIDENT,
Washington, D.C., January 15, 1969.

DEAR MR. PRESIDENT:

I am pleased to forward the Third Annual Report of the National Council on Marine Resources and Engineering Development entitled "Marine Science Affairs—A Year of Broadened Participation."

This Report highlights Government-wide progress toward goals of the Marine Sciences Act of 1966 ". . . to develop, encourage, and maintain a coordinated, comprehensive, and long-range national program in marine sciences for the benefit of mankind . . ." Building on strengths and accomplishments of the separate Departments and agencies in advancing our policies and programs, the Council has endeavored to:

—relate our ocean activities more directly to the needs and aspirations of our people;

—widen the opportunities for economic growth, world order, and enhanced quality of living for all citizens, by bringing marine sciences more directly into the mainstream of public policy;

—foster the transition from scientific study of the ocean to intensified application of scientific discoveries and higher-level policy concern;

—clarify Government-wide policies, priorities, and milestones and selectively advance priority programs such as international cooperation, the War on Hunger, Coastal Zone planning and management, and the Sea Grant Program;

—focus the resources of eleven Federal agencies toward common objectives, through improved internal management; and

—reduce institutional impediments that retard effective development of marine resources.

Although the Federal Government provides much of the leadership and support for ocean research and exploration, active participation by others is essential. *State and local governments* are responsible for the skillful management of our crowded shorelines. *Private industry* provides the entrepreneurship and capital to develop marine resources. The *universities* extend the forefront of scientific knowledge and train needed manpower. Finally, *other nations* are also rapidly moving seaward. Thus, we have intensified our consultations with all marine interests—at home and abroad—recognizing the necessity for broad participation and collective action in achieving marine science goals.

This Report describes Federal marine science programs and budgets, proposed for Fiscal Year 1970, for the following major purposes: international cooperation, military security, fisheries, transportation, Coastal Zone activities, health, and non-living resources. Complementing these efforts is a broad base of supporting activities: research and engineering, manpower and education, environmental services, and exploration and mapping. In addition, we have provided some unity to these diverse marine science activities in a chapter on marine geography that portrays man's present and projected uses of the seas.

To advance our Nation's stake in the sea, Federal funding for Fiscal Year 1970 is proposed at $528 million.

Under your leadership, this Nation has developed a new awareness of the importance of our coastal lands and ocean resources. We have begun a new

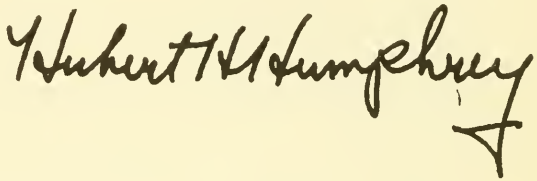
venture seaward, in the quest for fuels, food, and minerals—and for the natural beauty of the seashore.

We have taken new steps to reaffirm the freedom of the seas and have sought to insure that the deep ocean floor will be used for the benefit of all mankind. Your proposal for the International Decade of Ocean Exploration has been welcomed by the United Nations General Assembly and provides new opportunities for international cooperation in exploring the oceans and the ocean floor.

All who have contributed to our progress have been inspired by the promise of contributions of the sea to a better life.

Each of us is to some extent an explorer—eager to probe the mysteries of our planet, unable to resist the drama of the undersea world. The sea, too often taken for granted, offers fresh opportunities for individuals—and for nations—to explore our last geographical frontier, together.

Sincerely,



The President,
The White House,
Washington, D.C.

PREFACE

A Report to the President from the National Council on Marine Resources and Engineering Development, January 1969

THIS REPORT TO THE PRESIDENT ON MARINE SCIENCE AFFAIRS is prepared in accordance with Public Law 89–454, the Marine Resources and Engineering Development Act of 1966, which states that the President shall transmit to the Congress an annual report including (a) a comprehensive description of the activities and the accomplishments of all the agencies and departments of the United States in the field of marine sciences during the preceding fiscal year, (b) an evaluation of such activities in terms of the objectives set forth pursuant to Public Law 89–454, (c) such recommendations for legislation as the President may consider necessary or desirable for the attainment of the objectives of Public Law 89–454; and (d) an estimate of funding requirements of each agency and department of the Federal Government for marine science activities during the succeeding fiscal year.

The Marine Resources and Engineering Development Act was amended by P.L. 89–688, the National Sea Grant College and Program Act of 1966, which also requires an annual report by the President on sea grant colleges and programs.

This Report on Marine Science Affairs is submitted to the Congress in response to both requirements. It was prepared by the National Council on Marine Resources and Engineering Development. The Council, located in the Executive Office of the President, is composed of:

CHAIRMAN:

Hubert H. Humphrey, *the Vice President*

MEMBERS:

Dean Rusk, *the Secretary of State*
Paul R. Ignatius, *the Secretary of the Navy*
Stewart L. Udall, *the Secretary of the Interior*
C. R. Smith, *the Secretary of Commerce*
(Alexander B. Trowbridge until March 1, 1968)
Wilbur J. Cohen, *the Secretary of Health, Education, and Welfare*
(John W. Gardner until March 1, 1968)
Alan S. Boyd, *the Secretary of Transportation*
Glenn T. Seaborg, *Chairman, Atomic Energy Commission*
Leland J. Haworth, *Director, National Science Foundation*

OBSERVERS:

Thomas O. Paine, *Acting Administrator, National Aeronautics and Space Administration*
(James E. Webb until October 7, 1968)
S. Dillon Ripley, *Secretary, Smithsonian Institution*
William S. Gaud, *Administrator, Agency for International Development*
Charles J. Zwick, *Director, Bureau of the Budget*
Arthur M. Okun, *Chairman, Council of Economic Advisors*
Donald F. Hornig, *Director, Office of Science and Technology*

EXECUTIVE SECRETARY:

Edward Wenk, Jr.

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INTRODUCTION

During the past two and one-half years, national attention has been increasingly focused on the potential of the seas and on the importance of policies and programs to use the seas more effectively. The Federal Government has endeavored to provide the necessary stimulus and support and the leadership to meet public purposes and scientific opportunities—to promote economic growth, enhance the quality of our environment, and contribute to international peace and security through our ocean endeavors. Since mid-1966:

—The President has issued more than 20 policy statements including goals, priorities, and plans to mobilize our resources for intensified marine activities.

—The Congress has held more than 100 hearings and enacted more than two dozen new laws to promote broader, safer, and more rational use of the oceans and their resources.

—The United States has cosponsored five Resolutions adopted by the U.N. General Assembly, calling for broader international cooperation to explore and to develop the oceans and their resources for the benefit of mankind.

—The National Council on Marine Resources and Engineering Development has acted on more than 65 major ocean policy issues at 15 plenary sessions.

—The Commission on Marine Science, Engineering, and Resources has issued a major report on a national marine science program to meet present and future needs, including a recommendation for the establishment of a new independent Federal agency to serve as the focal point for civilian ocean affairs.

—California, Washington, Florida, and other States, industrial associations such as the National Security Industrial Association, professional societies, and other non-governmental bodies have taken steps to strengthen and broaden the marine science activities within their purview.

Underlying this re-awakened effort to realize more clearly our role as a maritime power is the mandate of the Marine Resources and Engineering Development Act of 1966 "to develop, encourage, and maintain a coordinated, comprehensive, and long-range national program in marine sciences for the benefit of mankind to assist in:

—protection of health and property;
—enhancement of commerce, transportation, and national security;
—rehabilitation of our commercial fisheries; and
—increased utilization of these and other resources." [1]

This mandate of the Congress and the President further identifies eight objectives related to these goals:

—the accelerated development of the resources of the marine environment;
—the expansion of human knowledge of the marine environment;
—the encouragement of private investment enterprise in exploration, technological development, marine commerce, and economic utilization of the resources of the marine environment;
—the preservation of the role of the United States as a leader in marine science and resource development;
—the advancement of education and training in marine science;
—the development and improvement of the capabilities, performance, use, and efficiency of vehicles, equipment, and instruments for use in exploration, research, surveys, the recovery of resources, and the transmission of energy in the marine environment;
—the effective utilization of the scientific and engineering resources of the Nation, with close cooperation among all interested agencies, public and private, in order to avoid unnecessary duplication of effort, facilities, and equipment, or waste; and

---

[1] Following are some abbreviations and definitions generally used in the marine sciences field:

The Act is customarily called the *Marine Sciences Act.*

The National Council on Marine Resources and Engineering Development is usually abbreviated to the *Marine Sciences Council.*

The Commission on Marine Science, Engineering, and Resources is usually referred to as the *Marine Sciences Commission.*

Marine science is a term employed in Public Law 89–454 to describe scientific research, engineering, and technological development related to the marine environment.

The *marine environment* is considered to include the oceans, the Continental Shelf and estuaries of the United States and its territories, the Great Lakes, and the resources of the oceans and Great Lakes.

—the cooperation by the United States with other nations and groups of nations and international organizations in marine science activities when such cooperation is in the national interest.

Initial governmental efforts to respond to these challenges were described in the First Annual Marine Sciences Report of the President, released in 1967, entitled "Marine Science Affairs—A Year of Transition." The Report emphasized the transition from scientific oceanography to application of these scientific discoveries and the transition from considerations largely at the program level to a new concern and responsibility at the policy level of government. The Second Annual Report, entitled "Marine Science Affairs—A Year of Plans and Progress," presented a broad range of policy considerations relating the potential of the oceans to major national goals and to action programs to aid in their achievement. It laid the basis for intensified government-wide planning efforts and for increased emphasis on selected priority areas such as the War on Hunger, international cooperation, and implementation of the Sea Grant Program.

During the past year, the Marine Sciences Council has endeavored to ensure that early initiatives were being supported and to develop a more rational institutional framework to sustain a long-term program. Major national purposes have been more clearly enunciated and impediments to progress have been isolated, including both gaps in scientific knowledge and barriers arising from institutional conflicts, neglect, or obsolescence. Marine science has been more effectively injected into the mainstream of public policy, and our maritime presence is being revived to serve the pressing needs of our society. A new emphasis has been placed on rational development of our Coastal Zone—the margin where the sea meets the land and the people—through cooperative programs with the States, on formulating a deliberate and concerted policy for Arctic development, and on steps to provide a framework of international law and of cooperation which will mitigate conflicts as nations utilize the marine environment more intensively.

This Third Annual Report, entitled "Marine Science Affairs—A Year of Broadened Participation," summarizes accomplishments in 1968, describes our policies and programs, and identifies our goals and milestones. It should complement the report of the Commission on Marine Science, Engineering, and Resources, released on January 11, 1969. Although there has not been time yet to consider the Commission's findings and recommendations in detail, they are referred to the incoming Administration for study and implementation as appropriate.

The first chapter of this Annual Report summarizes the major policy recommendations of the Marine Sciences Council and describes the FY 1970 Federal marine sciences budget—by agency, by public purpose, and by marine science function. The next chapter discusses this Nation's stake in the oceans in terms of marine geography—a physical, social, economic, and political geography. Man's present diverse uses of the sea are expressed

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quantitatively wherever possible, with selective projections of future growth. These challenges as to more effective use of the sea are followed in subsequent chapters by details of the Federal Government's response in carrying out the Marine Sciences Act. Because almost all maritime activities involve more than a single agency, the remainder of the Report follows the pattern of earlier years of delineating the Federal program by categories of purpose, rather than by agency.

The next six chapters describe Federal programs in marine sciences that serve the following purposes:

—expanding international cooperation and understanding;
—enhancing benefits from the Coastal Zone;
—strengthening military programs for national security;
—accelerating use of food from the sea;
—encouraging development of non-living resources; and
—facilitating transport and trade.

Three chapters then follow devoted to special new programs or policies:

—launching the International Decade of Ocean Exploration proposed by the President;
—advancing the Sea Grant Program; and
—formulating policies and programs for the Arctic.

Three chapters are then devoted to basic activities oriented to broad support of a number of major purposes:

—exploring the ocean environment;
—information management; and
—research, manpower, and engineering.

Each of these 12 chapters sets forth priority areas recommended by the Council to the President. To place these special areas in perspective, the Report also discusses ongoing efforts and associated funding for the Government as a whole and recent accomplishments within Federal agencies responsible for marine science operations. Finally, each of the twelve chapters discusses the activities of the Marine Sciences Council in setting government-wide goals, identifying priorities, and clarifying agency responsibilities, especially for programs crossing agency lines.

The responsibility for developing a sense of unity and direction in marine resources and engineering development involving numerous and varied missions, agencies, and institutional relationships was explicitly conferred on the President by the Marine Sciences Act. Chapter XV describes the policy planning and coordinating machinery that was provided by legislation to advise and assist the President and the new lines of communication that have been established between the Federal and non-Federal sectors.

The Report concludes with a brief discussion of the unfinished business immediately ahead in terms of unresolved policy issues.

"I cannot say that I am in the slightest degree impressed by your bigness or your material resources as such. Size is not grandeur, and territory does not make a nation. The great issue . . . is, what are you going to do with these things? —THOMAS HUXLEY

Chapter I

MARINE SCIENCES AND NATIONAL GOALS

From its earliest days this Nation has turned to the seas—for transportation and commerce, for national defense, and for natural resources.

Now 75 percent of our population lives in the States bordering the oceans and the Great Lakes, and 45 percent of our urban population, together with much of our industry, is concentrated in coastal counties. Many millions more visit the seashore—for swimming, boating, fishing, and relaxation, and coastal terraces of our sprawling urban areas have become the hub of many of our commercial and private endeavors.

Maritime shipping continues to intensify off our coasts—with a growing demand for expanded port, harbor, and navigation facilities. As international commerce grows at an ever increasing rate, the world's maritime industry is called upon to continue to accommodate the bulk of our foreign trade.

Ocean resources are playing a rapidly increasing role in our economic prosperity. Dramatic discoveries of promising new oil and gas fields off Alaska, California, and the Gulf Coast are certain to make major contributions to our economy. We have become the world's most lucrative market for fishing products. Also, hundreds of our small coastal communities depend heavily on a healthy fishing industry.

It is in the oceans that many of the expanding national interests of more than 100 coastal nations converge as they move farther from their coasts in the conduct of maritime and naval activities and in the search for

new resources. Thus, there is an urgent need in ocean affairs to prevent conflicts and disputes and a unique opportunity to promote international understanding—through collaborative development of a framework of law to guide ocean activities and through joint working projects to understand and develop the ocean and its resources. With present political uncertainties, our sea-based strategic deterrent and our naval presence provide stabilizing forces that enhance orderly economic and political growth within the international community.

Finally, the oceans provide a vast laboratory for scientific inquiry that will advance our understanding of fundamental environmental characteristics and processes. Improvements in our ability to understand, and possibly eventually to control, ocean and weather phenomena can affect the lives of many—the farmer, the resort owner, the ship captain, and the ordinary citizen.

Marine Science Opportunities

In spite of this growing intimacy of our society with the influences of the oceans, we have only begun to recognize the benefits of being a coastal nation. Among the opportunities and problems of our growing involvement with the sea are:

—Less than 10 percent of our Continental Shelf has been systematically explored although we are confident that abundant oil and mineral resources lie in other areas of the Shelf.

—Only a small portion of the fishery stocks off our coasts are being fully exploited, and of the total U.S. consumption of fish products less than one-third is provided by U.S. fishermen.

—Only 6 percent of our international maritime commerce travels in U.S. flag vessels.

—Only one-third of our coast has sufficiently detailed storm warnings in spite of the tens of millions of dollars of destruction annually in these areas.

—20 million children live in metropolitan areas within sight of potential water recreation areas but are often denied their use.

—Only 3 percent of our ocean and Great Lakes coastline has been set aside for public use or conservation in spite of rapidly growing demands for such areas.

—Pollution of our oceans and estuaries will increase many fold by the year 2000 unless there are drastic changes in waste handling; meanwhile, more than 50 million Americans engage in ocean swimming,

fishing, and boating, and many millions more are also directly affected by degradation of the quality of our coastal waters.

—The average age of our port structures is 45 years and the average age of our merchant ships is 20 years even though there is an urgent need to respond to the rapid changes in the character of ocean cargoes and technologies of cargo handling.

And on the international scene:

—Protein deficiencies plague millions in a number of the developing countries located near abundant fishery resources which could provide economical sources of protein.

—Unilateral acts to extend claims of national sovereignty great distances seaward threaten to erode the fundamental principle of freedom of the seas.

—Pollutants are gradually spreading to distant reaches of the seas as nations only slowly become concerned with maintaining the quality of ocean waters.

The Federal Response to the Challenge of the Ocean

During the past year the Marine Sciences Council has turned its primary attention to policy issues which can significantly affect economic growth, the development of our coastal environment, national security, and international understanding. Beginning with the President's call for expanded international cooperation in ocean exploration in his *State of the Union* message, the year was characterized by a new determination to establish a sound policy framework for carrying forth a program to meet the goals set forth in the Marine Sciences Act, namely, to:

—strengthen our economy by identifying new sources of food, fuel, and mineral resources; by encouraging innovation in marine technology; and by enlarging U.S. participation in the world's maritime activities;

—enhance the quality of urban living by arresting degradation and erosion of the shoreline, fostering rational waterfront development, and expanding water recreation opportunities;

—strengthen world understanding and security through international cooperative marine endeavors, international legal arrangements to avoid potential conflicts, and an unexcelled defense capability to deter aggression; and

—foster education and training of oceanographers, engineers, technicians, and those from other professions through collaboration with and assistance to our universities and technical institutes.

To assist in meeting these goals, the Council considered the following policy issues during 1968:

1. Strengthening the base for launching the *International Decade of Ocean Exploration,* proposed by the President, which should provide a broader and more effective framework for mobilizing the capabilities of many nations in concerted efforts to understand ocean phenomena and discover new ocean resources. Domestic and international planning are increasing to provide for a more rational delineation of ocean research and exploration priorities and responsibilities, and for improvements in the quantity, usefulness, and timeliness of data exchanged between scientists at home and abroad.

2. Improving the *international organizational structure* for planning, coordinating, and carrying out marine science programs of interest to the international community which are currently fragmented among a multiplicity of international organizations. The central role of the Intergovernmental Oceanographic Commission is being clarified and its ties with other marine science organizations strengthened to enable it to serve as a focal point for coordinating international ocean research activities.

3. Developing a *legal regime for the deep ocean floor* which will encourage private investment in development of seabed resources, reduce the possibilities of international conflicts and disputes, and promote U.S. security, economic, political, and scientific interests. A key step of the international community has been the establishment of a Committee of the U.N. General Assembly as a forum for considering a seaward limit of national jurisdiction and an international regime governing seabed activities beyond this limit. Consideration of seabed arms control measures should be primarily the responsibility of the Eighteen Nation Disarmament Committee.

4. Taking steps to encourage the States to carry out more effective programs of *planned use of the Coastal Zone* which take into account the many varied potential uses of our limited shoreline that is rapidly being subjected to more intensive human activities. State planning and decision making processes should be strengthened and made more responsive to both national and local needs, and multi-state issues should be given greater consideration in Coastal Zone planning and management.

5. Exploring with all interested parties the desirability and character of a possible *intergovernmental commission for the Chesapeake Bay* which is beset by conflicts between the many users of the estuary. Also, multidisciplinary research activities concerning the impact of these conflicting uses are being focused around a hydraulic model of the Bay.

6. Broadening the *coordinating responsibility of the International Joint Commission* for activities in the Great Lakes since any change in

the character of the Lakes, such as pollution, water levels, and ice conditions, has an impact on both the United States and Canada.

7. Intensifying *deep ocean technology research and development* to enable the Navy to respond to increasing demands for operations in deep water and to provide advanced engineering knowledge upon which the Navy can draw to meet requirements of future military systems. This effort is also contributing to a general engineering capability to meet present and future civilian needs.

8. Strengthening the *harvesting sector of the domestic seafood industry,* which in many areas cannot successfully compete with foreign fishing fleets off our coasts due to high costs of domestic fishing operations. Possible steps are being considered to (a) assist States in modifying laws and regulations that limit the efficiency of our fishermen, (b) improve the fishing vessel subsidy program, and (c) increase opportunities for vertical integration of the fishing industry.

9. Advancing *development of fish protein concentrate* technology as an integral part of the Food-from-the-Sea Program to expand the use by developing countries of fishery stocks which now lie dormant near many areas of malnutrition. Construction and operation of an FPC demonstration plant in the United States should assist commercial development of economical production processes, while overseas market development activities should facilitate commercial investments and ready acceptance of FPC in needy areas.

10. Encouraging private industrial *development of fuels and minerals* increasingly needed in the United States and worldwide which have been identified on the Continental Shelf and Slope. Programs are directed to a reevaluation of offshore leasing policies, protection of the environment from possible harmful side effects of extraction activities, and reconnaissance surveys of the Continental Shelf.

11. Instituting new measures to insure *safety of life and property* as maritime activities and congestion increase along our coasts and on the high seas. Specific steps include (a) implementation of the newly developed National Contingency Plan in the event of a pollution emergency, (b) development of a worldwide navigation plan incorporating advanced land and satellite-based technology to serve non-military needs, (c) improvement of safety standards for offshore structures, (d) designation of additional sea lanes to assist in the flow of ocean traffic, and (e) establishment of safe procedures and rescue services for civilian submersibles and underwater activities.

12. Preparing for *development and redevelopment of our ports and harbors* which are too often characterized by obsolescent facilities and waterfront slums. It will be necessary to incorporate new technology into a national port system that will serve ocean shipping of the future, very likely to be characterized by much deeper draft bulk carriers,

containerization, and express and feeder services. A conceptual framework is being developed to provide the basis for a major study of future port requirements to be conducted in cooperation with all interested parties.

13. Formulating *policies and programs for the Arctic,* an area receiving increased international attention in view of its strategic importance and emerging resource potential. Preliminary steps are being taken towards enunciation of a national Arctic policy and designation of appropriate mechanisms to carry forth such a policy, and capabilities are being strengthened for Arctic and subpolar marine research.

14. Emphasizing *Sea Grant investments* for training specialized manpower, particularly ocean engineers and technicians, that will be needed for technological development of marine resources in the 1970's. The program will assist in responding to regional maritime needs by establishing research and training centers in State and private universities, community colleges, and technical schools, and research results will be disseminated to industry and the public.

15. Fostering *marine applications of new technology* which can benefit science and industry. Development of buoy technology to collect oceanographic and meteorological data as a basis for later decisions on a worldwide ocean data station network is being accelerated, and spacecraft already programed for other purposes will conduct observations of sea ice, currents, temperature patterns, and surface waves.

16. Improving *capabilities for management of marine science information* which is critical for successful research and development activities through broader use of automated equipment at the National Oceanographic Data Center, a comprehensive study of data needs to provide a framework for an expanded environmental data program, and preparation of catalogs of current research projects.

17. Strengthening the Nation's base of *marine research and technology* which undergirds many aspects of the total national effort. Programs include support of educational institutions to accommodate the rising student enrollments in marine sciences; improvement of national facilities for testing, standardization, and calibration of oceanographic instruments; and improvement of civilian underwater communications.

The Federal Marine Science Budget for FY 1970

The proposed FY 1970 Federal program, military and civilian, totals $528 million, up about 12 percent over FY 1969 and about 22 percent over FY 1968. All of the Federal activities identified within the scope of marine

science, engineering, technology, and resources development are detailed by major purpose in Table I–1, by department and independent agency in Table I–2, and by function in Table I–3. Figure I–1 graphically shows where the Federal marine science and technology funds are spent. Details by Federal organization, major purpose, and function are given in Appendix A. Many of the programs are described in detail in subsequent chapters of this Report.

Table I–1—Total Federal Marine Science Program by Major Purpose [a]

(In millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's Budget FY 1970
1. International Cooperation and Collaboration	9.6	9.5	11.7
2. National Security	119.9	128.1	143.0
3. Fishery Development and Seafood Technology	40.1	43.8	44.5
4. Transportation	11.1	10.6	18.6
5. Development of the Coastal Zone	27.6	29.1	29.6
6. Health	5.3	5.4	5.3
7. Non-Living Resources	7.3	8.0	8.6
8. Oceanographic Research [b]	78.1	[c] 93.3	93.5
9. Education	7.0	7.5	9.2
10. Environmental Observation and Prediction	28.8	31.6	32.1
11. Ocean Exploration, Mapping, Charting, and Geodesy	75.7	83.0	99.1
12. General Purpose Ocean Engineering	19.2	18.3	29.5
13. National Data Centers	2.1	2.3	3.2
Total	431.8	471.5	528.0

[a] Many programs of the Departments of Defense, Commerce, Interior, and Transportation, and other agencies related to marine science affairs are not included.

[b] Research beneficial to more than one of the other major purpose areas.

[c] Includes $14.5 million for Coast Guard sub-polar oceanographic research ship. Funding for other ships is included in the relevant major purpose category.

Table I–2—Total Federal Marine Science Program by Department and Independent Agency [a]

(In millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's Budget FY 1970
Department of Defense	240.6	262.3	297.9
Department of the Interior	70.5	76.2	78.2
National Science Foundation	38.1	35.0	45.4
Department of Commerce	33.6	33.4	40.6
Department of Transportation	15.4	34.1	32.3
Atomic Energy Commission	13.8	10.4	11.4
Department of Health, Education, and Welfare	6.5	6.9	6.8
Department of State	6.6	7.0	7.1
Agency for International Development	3.0	2.5	4.6
Smithsonian Institution [b]	1.9	1.9	2.0
National Aeronautics and Space Administration	1.8	1.8	1.7
Total	431.8	471.5	528.0

[a] Many programs of the Departments of Defense, Commerce, Interior, and Transportation, and other agencies related to marine science affairs are not included.

[b] Excess Foreign Currency Funds are not included. See Appendix A–7.

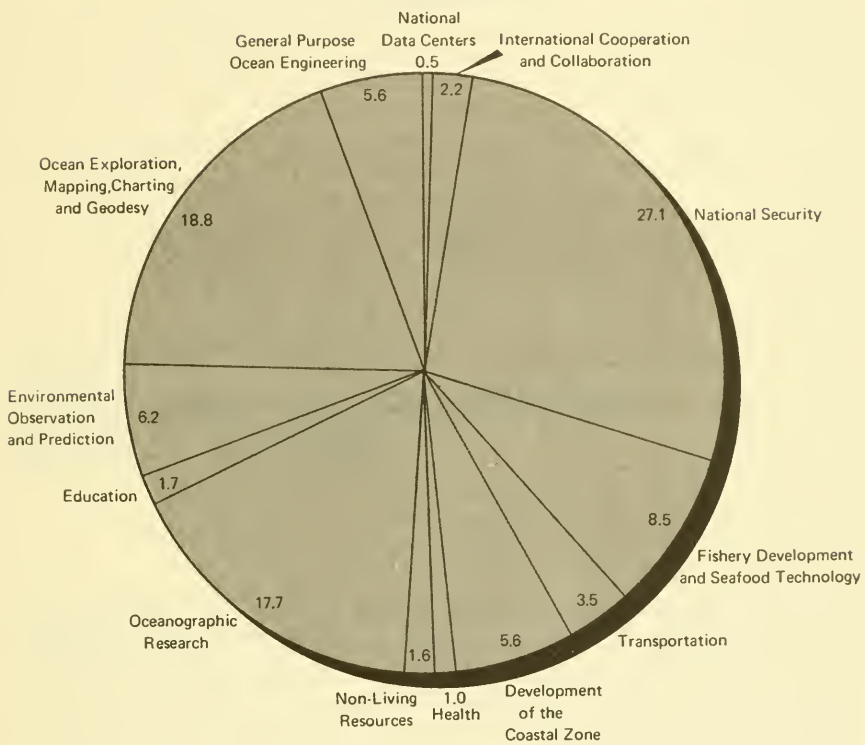
Table I–3—Total Federal Marine Science Program by Function

Summary

(In millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
Research and Development	245.4	248.3	297.9
(a) Research (basic and applied)	116.4	126.7	150.6
(b) Development of new equipment and technology	129.0	121.6	147.3
Investment	55.5	77.8	70.1
(a) Ships	7.6	15.1	2.3
(b) Major equipment	29.3	42.4	47.5
(c) Shore facilities	13.9	15.5	13.3
(d) Other	4.7	4.8	7.0
Operations	130.9	145.4	160.0
(a) Surveys	106.0	118.7	130.9
(b) Services	18.4	19.5	21.4
(c) Other	6.5	7.2	7.8
Total	431.8	471.5	528.0

Figure I–1—The Marine Science and Technology Dollar, FY 1970
(in percent)



"Ocean, wherein the whale
Swims minnow-small."
—WILLIAM ROSE BENÉT

Chapter II

A PERSPECTIVE FOR MARINE SCIENCE AFFAIRS

Marine Science Affairs—the title chosen for these Reports—denotes the evolving relationship between marine sciences and the affairs of man. The increasing relevance of marine sciences to our society leads us first to consider the broad political, economic, and social fabric of our Nation's activities, and then to define how the oceans may provide alternative ways to achieve our goals and aspirations. Marine research and development programs are visualized as means rather than ends. Thus, progress in marine science affairs requires us to define public purposes and to formulate public policies that will guide and stimulate our scientific and engineering efforts to realize the ocean's potential benefits.

The major challenges that lie ahead do not terminate at the water's edge. Neither do their solutions. As the world population outraces its food supply, the sea offers the possibility of significant new sources for food. As world requirements for energy and minerals grow faster than population, ocean resources hold the promise of additional riches. As coastal cities become even more crowded, the oceans can enhance the quality of urban living, particularly if the natural heritage of our shoreline is preserved and if there are new opportunities for people to refresh themselves at the seashore. Finally, as the world community of nations continues to explore new avenues to peace, the ocean suggests additional patterns of cooperation which can contribute to world order and understanding.

The uses of the sea thus become the primary motivation for expanding our comprehension of it. While the focus of our research is primarily on possible applications for national security, economic growth, and attainment of social goals, we also recognize the inherent human curiosity about the world around us—the desire to explore and seek adventure. Also, knowledge and understanding of the seas are sought in order to avert potential conflicts between uses of the oceans for different purposes before they arise, and to settle them if they arise.

To provide a perspective for the Federal Government's $528 million marine science program described in later chapters, this chapter seeks to present an abstract of man's uses of the sea. An attempt has been made to quantity these uses wherever reliable statistics are available although the presentation is necessarily incomplete.

These uses derive their unity from the common environment in which they take place—namely, the oceans of the world and their coastal margins. In brief, this chapter sets forth the present status of the ocean's relationship to people.

The Global Geography of the Ocean

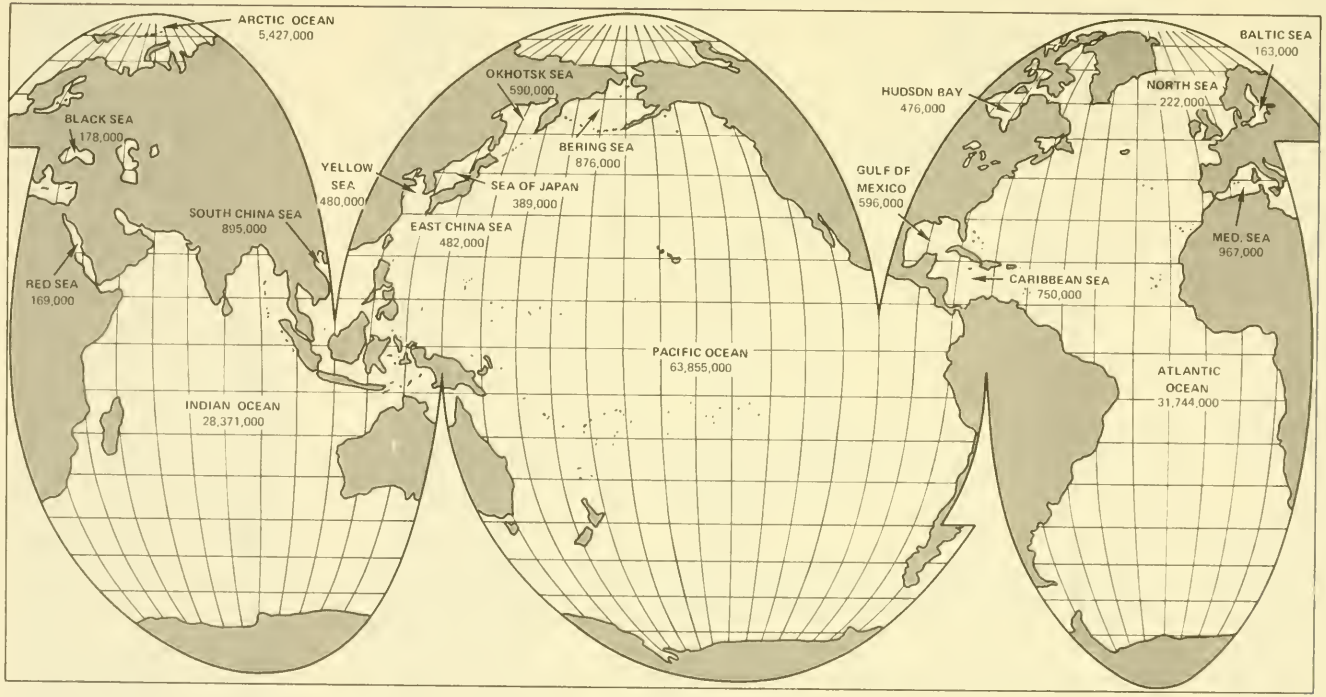
From space, the earth appears as a globe substantially covered by water. The vastness of the ocean is sometimes difficult to comprehend. As suggested in Figure II–1, we know that the sea covers some 140 million square miles or 71 percent of the earth's surface; continental masses and lesser islands occupy less than 29 percent of the total surface. These land masses are surrounded by water with depths averaging two-and-one-half miles. The submarine landscape encompasses vast topographic features including continental shelves and slopes, canyons, seamounts, and broad abyssal plains. The deepest trench is further below sea level than the highest mountain is above.

A generalized geological cross section of the ocean near land is depicted in Figure II–2; it should be recognized that the land-sea profile varies greatly from place to place.

The underwater extension of the continents to a depth of 100 fathoms is equivalent in area to approximately one-fourth the area of the continental land masses. The breadth of these submarine extensions varies from coastline to coastline. Offshore the United States, there are about 850,000 square miles at depths less than 100 fathoms: off Alaska 550,000 square miles, off the Atlantic Coast 140,000 square miles, off the Gulf Coast 132,500 square miles, and off the Pacific Coast 26,500 square miles. Table II–1 identifies

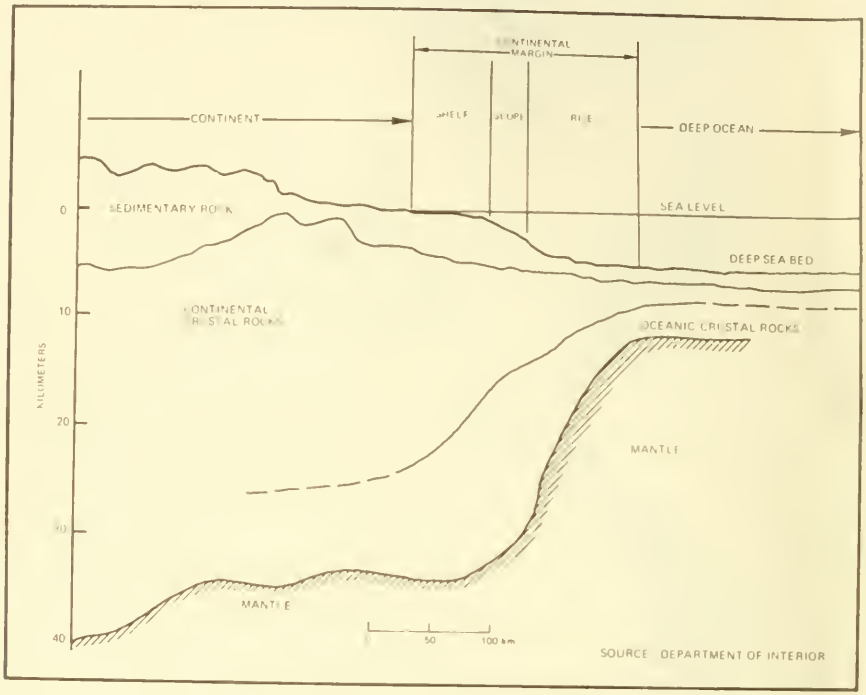
Figure II–1—The Global Sea

(Areas of Selected Seas in Square Miles)



Source: Department of Commerce.

Figure II-2—Generalized Geological Cross Section of Continental Margin



selected countries of the world which border extensive ocean areas of depths less than 1,000 fathoms.

These physical attributes of the oceans provide a partial understanding of man's life; for geography affects use, and man relies on the seas for transportation and commerce, food, fuel and minerals, recreation, waste disposal, and security.

The Great Commercial Highway

Of all the uses of the sea, the one which is indispensable to modern society is maritime transport. Today's maritime trade routes form lifelines for the exchange of raw materials and manufactured goods vital to the economy of almost every nation. Additionally, a nation's merchant marine can be a profitable enterprise, providing a source of wealth, earning foreign exchange, and enhancing national prestige. It can constitute a military resource and

Table II-1—Countries with Extensive Adjacent Shallow Ocean Areas

	Approx. coastline (miles)	Approx. area (square miles)	
		(Less than 100 fathoms)	(Between 100–1000 fathoms)
Argentina	2,415	331,000	52,960
Australia (including New Guinea)	20,125	827,500	556,080
Indian Ocean Islands	N.A.	2,648	112,540
Brazil	4,255	264,800	90,032
Burma	1,414	83,412	26,480
Canada	12,650	926,800	397,200
China (Mainland)	4,025	264,800	39,720
Denmark	N.A.	N.A.	N.A.
Faeroe Islands	178	7,944	52,960
Greenland	5,750	79,440	331,000
France	1,591	54,284	12,578
Indian Ocean Islands	N.A.	23,832	140,344
Pacific Ocean Islands	N.A.	38,396	152,260
Iceland	1,242	29,128	152,260
India	3,162	105,920	66,200
Indonesia	23,000	503,120	N.A.
Ireland	759	47,664	29,128
Malaysia	2,127	165,500	N.A.
Mexico	5,750	132,400	66,200
New Zealand	3,185	79,440	529,600
Norway	1,897	39,720	152,260
Portugal (including dependencies)	N.A.	79,440	185,360
South Africa	1,644	60,904	101,948
South West Africa	897	26,480	59,580
Spain	1,725	26,480	60,904
Atlantic dependencies	N.A.	31,776	34,424
Thailand	1,495	99,300	19,860
U.S.S.R.	26,450	1,324,000	926,800
U.K.	3,220	52,960	99,300
Bahamas	1,610	48,988	25,156
Falkland Islands	N.A.	39,720	139,020
Indian Ocean Islands	N.A.	63,552	72,820
Pacific Ocean Islands	N.A.	22,508	68,848
U.S.	13,112	860,600	440,000
Venezuela	1,150	35,748	39,720
Vietnam	995	111,216	55,608

N.A.—Not readily available.

Note: These estimates are for illustrative purposes only. They will vary widely depending on assumptions concerning seaward extension of international boundaries, effect of irregularities in ocean floor contours, demarcation of shallow areas adjacent to several countries, and other factors.

Source: Departments of State and Navy.

serve national and international political purposes. History has shown that nations which trade with each other develop enduring cultural bonds and political and economic ties.

The need for maritime transportation is increasing. The growth of world population, the expansion of economic activity, and the accompanying in-

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crease in the international exchange of goods and services inevitably enlarge worldwide requirements for transporting goods and people over the principal oceanic trade routes. Figure II–3 depicts the principal trade routes of particular importance to the United States. Furthermore, many of the developing countries require increasing sea transport to carry more finished goods, fossil fuels, and raw materials essential for their increasing populations. As shown in Figures II–4 and II–5, the more advanced nations have considered the development of maritime transportation essential, and oceanborne trade will grow rapidly in the decades ahead.

Maritime transportation is also essential to national security. While air movement is becoming increasingly important, especially for high value, low density cargo the bulk of worldwide intercontinental commerce and military goods still move over the sea.[1] Today, 97 percent of U.S. military tonnage is transported to Vietnam by ship. Other military assistance and foreign aid programs also rely heavily on sea transportation.

A collateral benefit of marine transportation in some countries is the shipbuilding industry's contribution to the economy. For example, by the end of 1968, ships of 200,000 tons and upwards were being built in seven Japanese dry docks. Two more docks will begin service in 1971. Most growth in ship construction capacity during the next three to five years is expected in Europe. Eight massive building ways are now being operated, planned, built, or completed in Britain, France, Portugal, Italy, Germany, and Scandinavia.

Because of the rapidly increasing size of ships, particularly of bulk carriers, the actual number of ships in the world fleet is expected to grow more slowly than in the past. The number of supertankers larger than 200,000 DWT is expected to comprise one-half of the total world tonnage capacity by 1973. By 1983, tankers in the 400,000 to 600,000 DWT category may comprise 10 percent of total world tonnage capacity.

[1] Costs per ton mile of various ships and aircraft

Vehicle	Speed in knots	Cost in cents per ton mile
Current Airfreight	400	30
1970 Airfreight	550	20
Conventional Cargo Lines	20	1.0
Container Ship	20	0.65
50,000 DWT Tanker	16	0.18
100,000 DWT Tanker	16	0.11
200,000 DWT Tanker	16	0.08

Note: Costs for unsubsidized ship and aircraft for typical trans-Atlantic route, including handling the cargo on and off the vehicle, but not including packaging or inland transportation.

Source: Benford, H. "Ocean Transport—an Outline of Commercial Requirements for Ships," Midwest Research Seminar in Meteorology and Oceanography, May 1966.

Figure II-3—Principal Oceanic Liner Trade Routes Directly Related to U.S. Interests

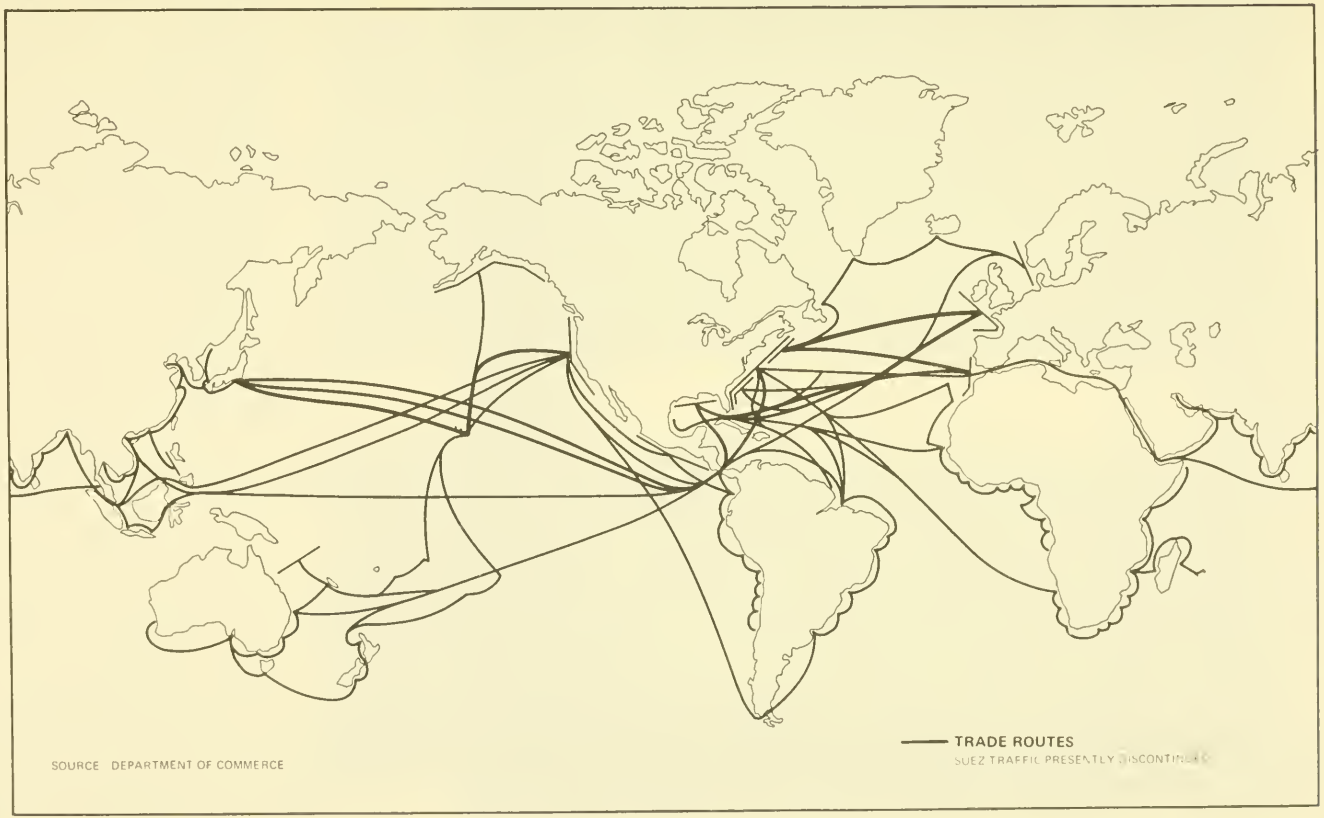


Figure II–4—Projections of Oceanborne Trade

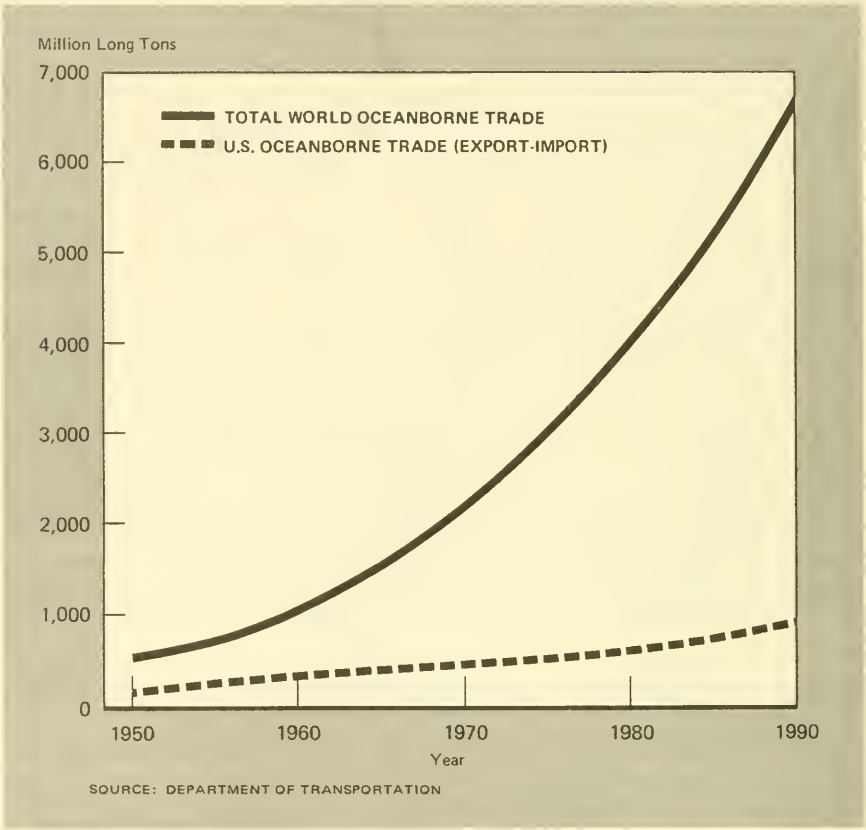
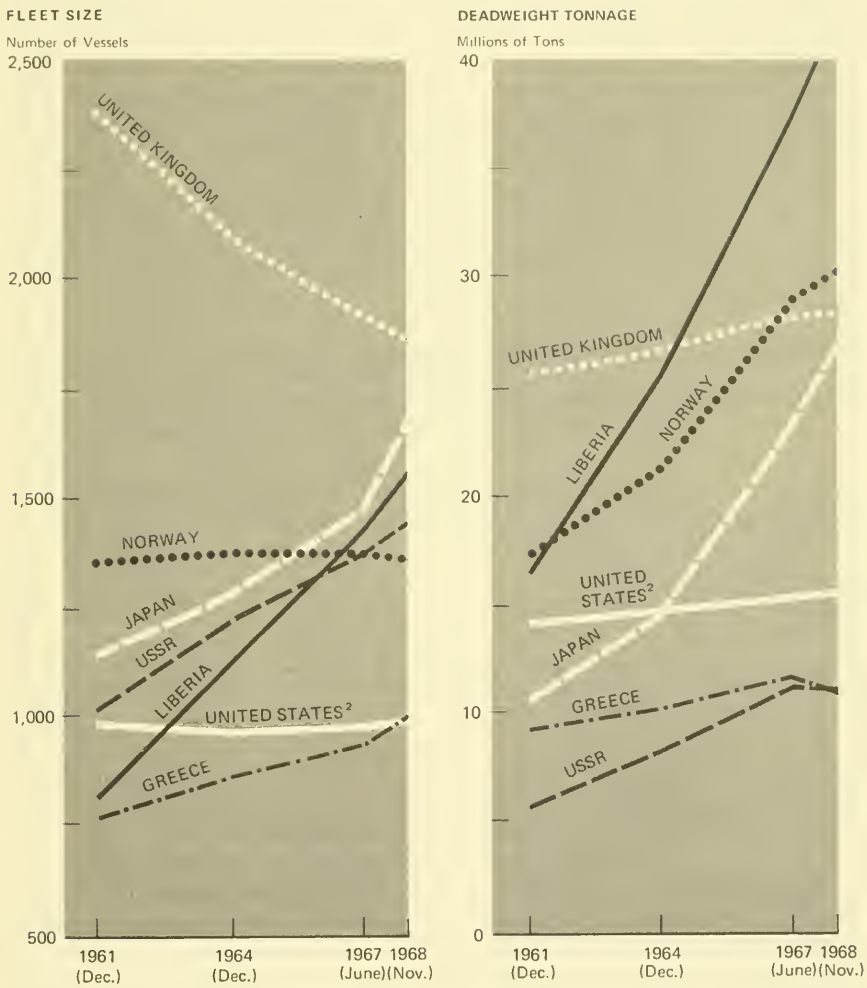


Figure II–5—Merchant Fleets of the World[1]



[1] Oceangoing steam and motor ships of 1000 gross tons or more. Excludes ships operating exclusively on inland waterways and special ships such as channel ships, icebreakers, military ships, etc.

[2] Only privately-owned U.S. ships are included. U.S. government ships, excluding the reserve fleet, rose from 64 vessels in 1961 to 201 vessels in 1967 but this largely reflects activation of reserve ships for war duty.

Sources: Merchant Fleets of the World, 1961, 1964, 1967, 1968, Maritime Administration, U.S. Department of Commerce

Likewise the industry is evolving new techniques. Most non-bulk commodities will be moved in unitized loads in the future. By 1973, 23 percent of all U.S. flag cargoes may move in container ships. By 1983 that figure should increase to over 40 percent of all liner cargoes. By using high speed container ships in single point-to-point transoceanic shuttle service, with efficient intermodal integration moving loads between shore and ship, total delivery time may be reduced sufficiently to compete more favorably on a time-cost basis with air freight.

But as ocean traffic increases, so do its hazards. Statistics on commercial vessel casualties and associated deaths for FY 1968 are presented in Table II–2. They provide an insight of the implications of growing ocean traffic and the urgency of greater safety measures.

Table II–2—Commercial Vessel Casualties and Associated Deaths and Injuries, Fiscal Year 1968

	Nature of casualty		
	Collisions	Groundings	Heavy weather damage
Vessel casualty (ships):[a]			
Number of casualties	409	525	164
Number of vessels involved	742	656	175
Number of deaths/injuries	2/7	0/1	0/0
Vessels totally lost	10	39	29

[a] In general, includes vessels over 100 gross tons.
Source: Department of Transportation.

The Confluence of Man and Sea

The most intensively used and most accessible part of the ocean environment is the Coastal Zone—the margin where the land, the water, and the people meet and interact. This Coastal Zone encompasses a broad variety of physical features; it is characterized by dynamic interaction of wind, tides, currents, waves, storms—and land; it supports a rich variety of flora and fauna. The great natural beauty of the shore holds fascination for everyone.

This region has great values for man. The Coastal Zones of the world historically have been the important sites of industry and commerce. The development of port cities has provided springboards of national culture.

Increases in coastal population and attendant demands for land, food and water, energy, and recreation are giving rise to greater pressures for intensive and often conflicting uses of a nation's coastal regions.

By the year 2000, the U.S. population will increase by about 60 percent while GNP and disposable personal income are expected to increase three- to four-fold. Thus, production of goods and demand for services will far outstrip population increase. This rising standard of living, together with the growing coastal concentrations of our population shown in Figure II–6, will add to the competition for the Nation's limited coastal resources, with the development of marine industries contributing to coastal economics.[2]

As significant as the rapid growth of urban population is the sharp rise in leisure time available for recreational use. With nearly one-third of the Nation's population concentrated in the major coastal cities and more than double that number near the shoreline, it can be expected that coastal areas will be subject to increasing pressure for recreation. Table II–3 summarizes the dramatic rise expected in coastal recreation participants.

Table II–3—Growth in Selected Coastal Recreational Activities

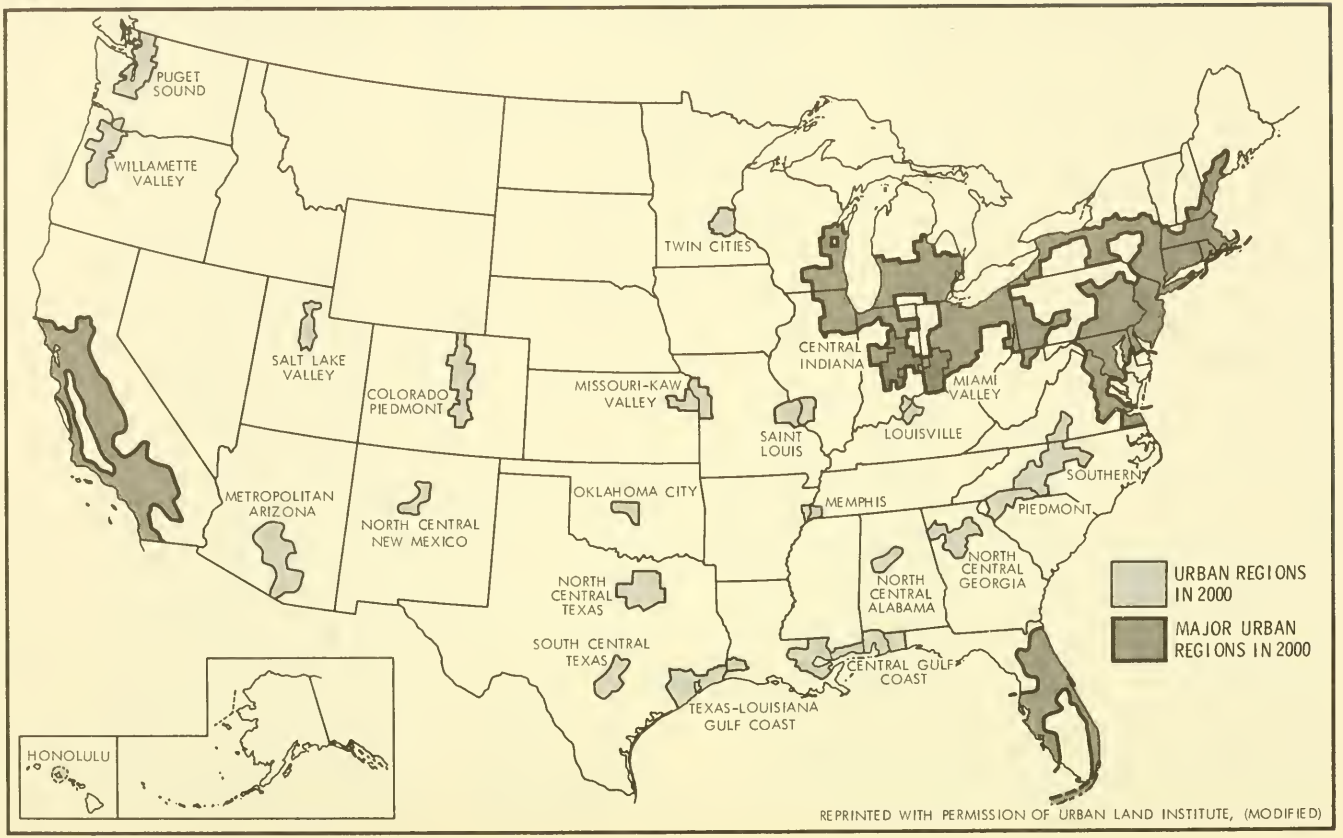
Type of Recreation	Participants (millions)	
	1964	1975
Swimming	33	40
Surfing	1	4
Skin diving	1	3
Pleasure boating	20	50
Sport fishing	8	16
National Park and Forest recreation	18	44

Source: Departments of Commerce, Interior, and Transportation.

This increased use of the Coastal Zone will contribute to employment, land development, and investment at a very high rate. But accompanying these developments will be the problems of public access to coastal lands, waste disposal, and natural degradation of the coastline. Modern industrial societies create liquid, gas, and solid wastes at rates faster than the population growth itself. Coastal populations will of necessity increase their total annual expenditures to dispose of liquid and solid municipal wastes.

[2] Table H–8 of "Marine Science Affairs—A Year of Plans and Progress," March 1968, presents statistics on employment in selected marine industries on our coasts.

Figure II-6—Increased Urbanization Projected for Year 2000



Pollution presents serious economic consequences. For example, it is estimated that 10.7 million acres of our bays and estuaries could be used for shellfish culture; even today pollution prevents the use of more than 10 percent of these waters. In some areas commercial shad and oyster fisheries have been destroyed because of polluted rivers and estuaries.

Weather also affects coastal activities. The hazards and losses from hurricanes, storms, wave-induced erosion, and floods are serious. Table II–4 summarizes losses from North Atlantic tropical cyclones.

Table II–4—Losses from North Atlantic Tropical Cyclones

Year	Loss of life in United States	Damage in United States (millions of dollars)	Loss of life in all areas including United States	Damage in all areas including United States (millions of dollars)
1943–1947.....	140	402. 9	1, 205	439. 9
1948–1952.....	29	117. 9	315	149. 9
1953–1957.....	827	1, 924. 8	3, 586	2, 608. 8
1958–1962.....	139	736. 8	627	1, 106. 8
1963–1967.....	206	2, 188. 2	8, 653	3, 243. 6

Source: Department of Commerce.

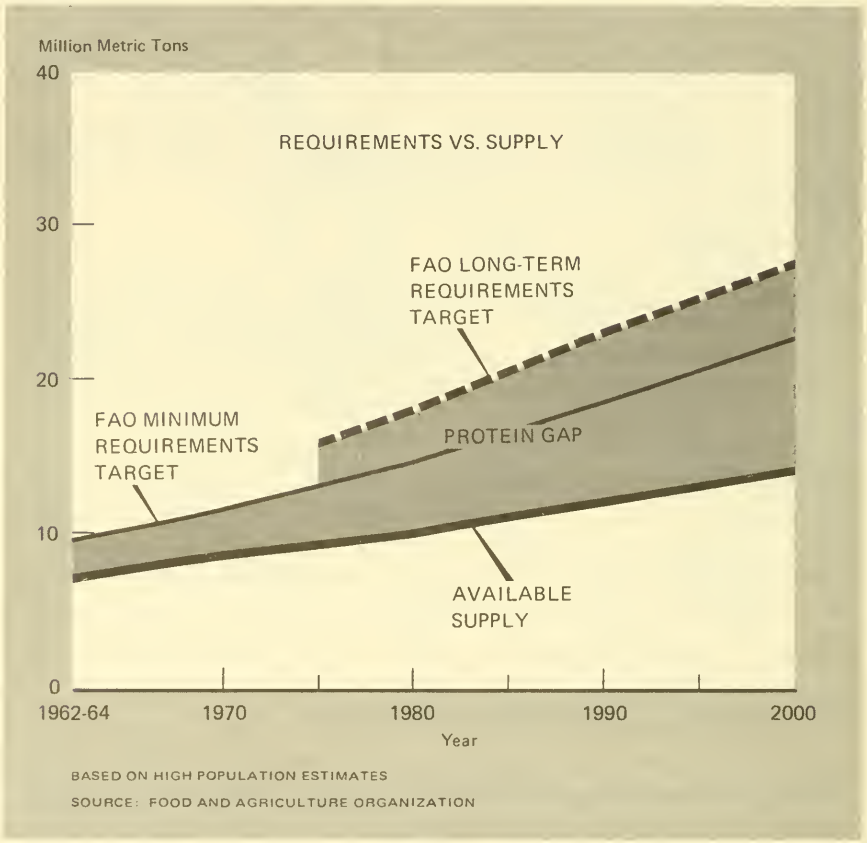
A Storehouse of Critically Needed Protein

One of the ocean's great resources is food. More effective use of the living resources of the ocean can provide better and less expensive food to help alleviate the world hunger problem, provide a wider variety of nutritious foods for affluent societies, and stimulate economic opportunities at home and abroad by a competitive fishing industry.

Many developing areas of the world are critically short of animal protein. The developing world's protein gap is depicted in Figure II–7. Protein malnutrition can have a devastating effect on the growth of school children, and today one-half of the world's population lives in countries where protein malnutrition is endemic.

The ocean's living resources offer hope for alleviating a portion of the nutrition crisis. Fish are approximately 15 percent protein; they contain a favorable balance of amino acids required in human diets. Conservative estimates indicate the world fish catch can be increased at least four times without depleting stocks. This unused potential of fish protein could meet a significant fraction of present and future world needs.

Figure II–7—Projected Animal Protein Gap in the Developing Countries

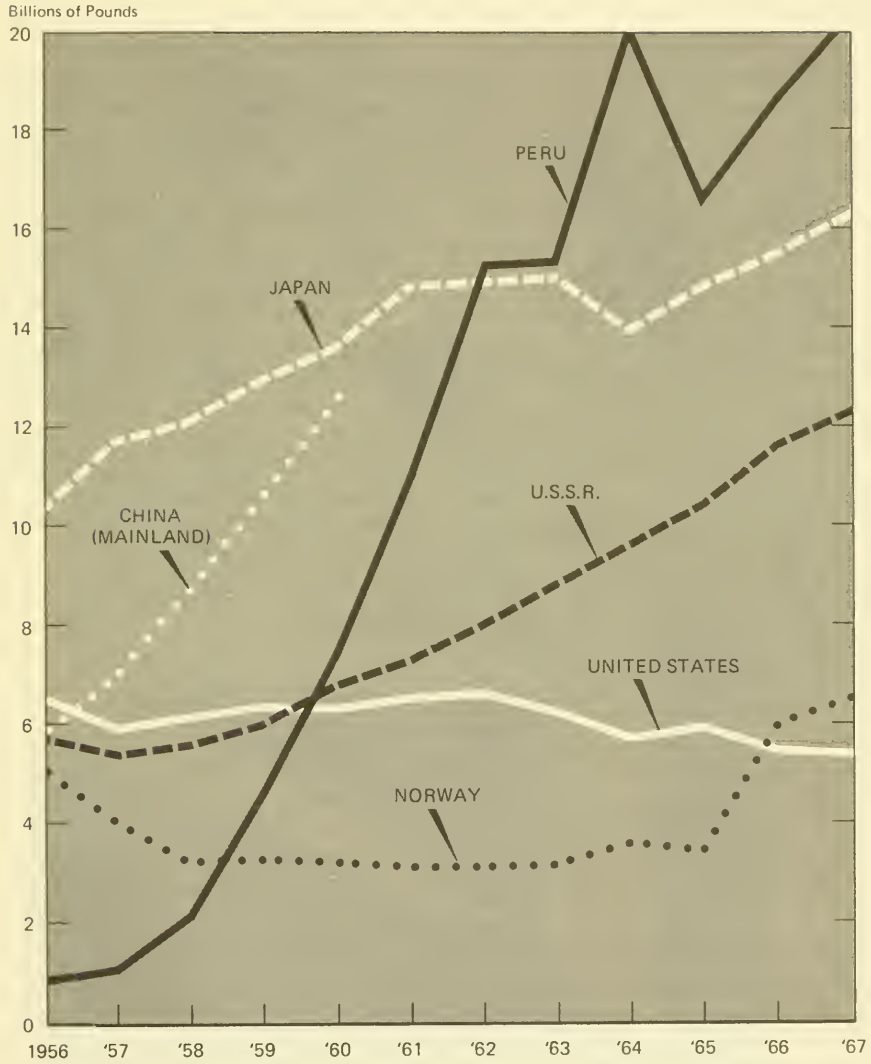


Currently, six nations are catching approximately 57 percent of the total world fish catch. Figure II–8 shows the growth of these catches, while Figure 11–9 depicts the major fishing areas of the world.

In the United States many harvesting sectors of the fishing industry are in decline. While the U.S. fish catch has remained relatively constant for the past 30 years, the processing and marketing portions of the industry have grown steadily, supplied by increasing U.S. fish imports and expansion of U.S. fish processing firms into areas abroad for raw materials.

Yet the use of fishery products in the United States for all purposes has increased steadily over the years in both absolute and per capita terms. The annual U.S. fish utilization of 70 pounds per person is among the highest in the world. Figure II–10 shows the growth of the U.S. market and the mounting share of the U.S. demand for fish being satisfied by imports.

Figure II–8—Catch of Seafoods by Leading Countries



NOTE: LIVE-WEIGHT BASIS

SOURCE: FOOD AND AGRICULTURE ORGANIZATION, DEPARTMENT OF INTERIOR

Figure II–9—World Catch by Major Fishing Areas

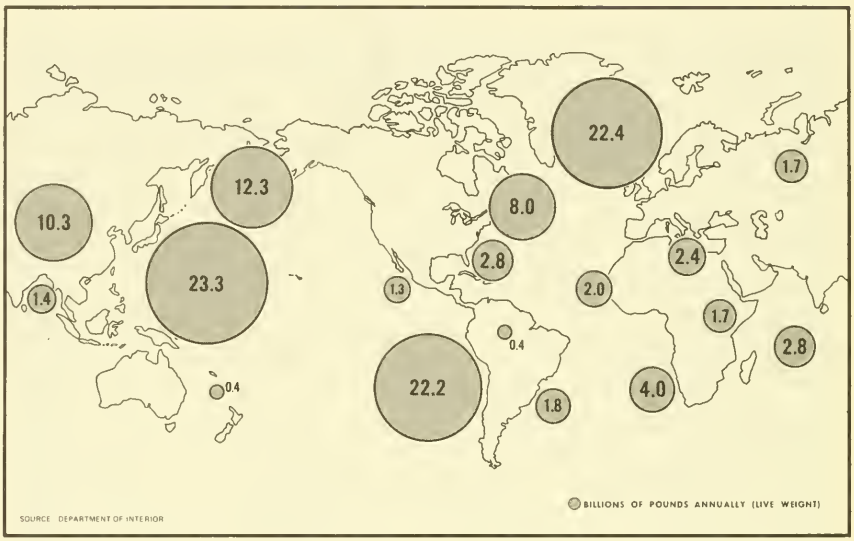
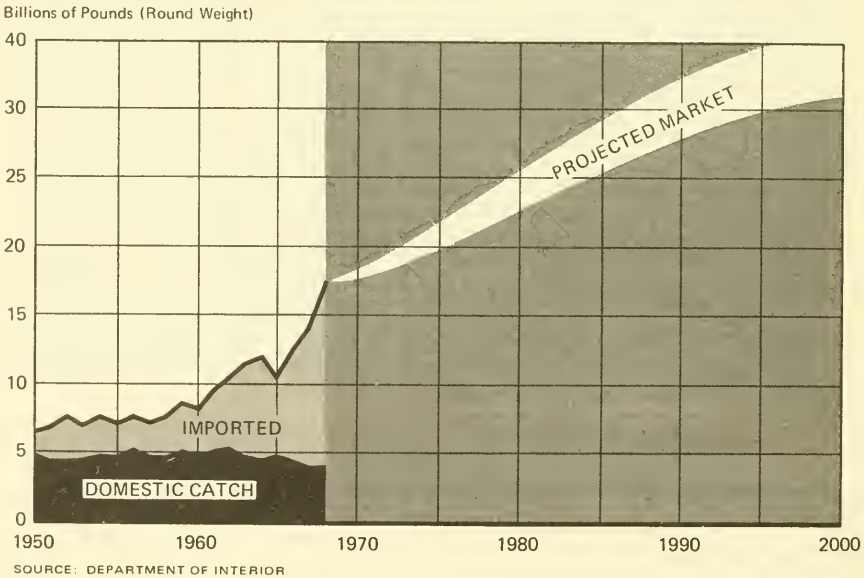


Figure II–10—U.S. Market for Fishery Products

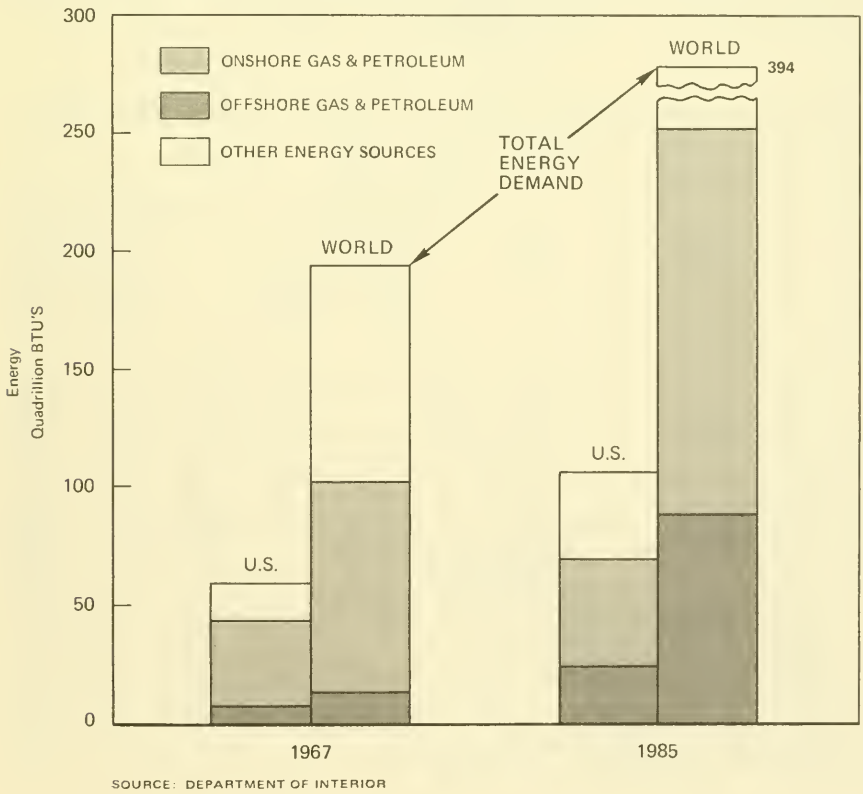


A Growing Source of Fuels and Minerals

Minerals and fuels are essential to the world's industrial economy. In the last 30 years the U.S. has consumed more minerals and fuels than the entire world used in all previous history. Competition for low cost mineral raw materials will intensify as both developed and developing nations step up their industrial economies and encourage the processing of their own ores. To assure that the United States has an adequate and dependable supply of minerals and fuels, existing resource bases must continue to be diversified and the discovery rates of new economical sources increased.

Projected world and U.S. energy demands to the year 2000, as well as the estimated quantities of offshore oil and gas required to satisfy these demands, are summarized in Figure II–11. The United States is the heaviest consumer

Figure II–11—Projected Demand for Offshore Gas and Petroleum



SOURCE: DEPARTMENT OF INTERIOR

of petroleum, relying both on imports and domestic production. Similarly, Western Europe is a heavy consumer, producing less than 10 percent of the oil it consumes. Figure II–12 portrays the patterns of international oil trade that have developed to satisfy disparities in supply and demand.

The reserves of crude oil on the Continental Shelves of the world to partially meet this demand are described in general terms in Table II–5. The reserves in North America are considered adequate to sustain offshore production for a number of years, and recent discoveries off the coasts of Alaska, California, and the Gulf States suggest that additional deposits may soon be located.

Exploration of the U.S. Continental Shelf has accelerated in recent years, resulting in dramatic increases in offshore oil and gas production. In 1967, offshore petroleum production had doubled 1964 levels, representing 13 percent of total domestic production and satisfying 7 percent of total domestic demand. Similarly, offshore drilling is taking place throughout the world as shown in Figure II–13. In 1967, the Free World produced 0.86 billion barrels of offshore crude oil, almost double the production of 1964. This is slightly less than 7 percent of Free World demand. Natural gas produc-

Table II–5—Petroleum Potential of Continental Shelves of the World [a]

(Areas in thousands of square miles)

Region	Shelf area [b]	Excellent potential [c]			Fair potential [d]		
		Area	Percent of total Shelf of region	Percent of world excellent Shelf area	Area	Percent of total Shelf of region	Percent of world fair Shelf area
Total World	10, 763	188	1. 8	100. 0	1, 657	15. 3	100. 0
North America	2, 140	40	1. 9	21. 3	315	14. 7	19. 0
South America	910	20	2. 2	10. 6	150	16. 5	9. 1
Middle East, Asia	200	40	20. 2	21. 3	65	32. 5	3. 9
East Indies Islands (including Philippines)	1, 350	35	2. 6	18. 6	305	22. 6	18. 4
Iron Curtain Countries	2, 718	35	1. 3	18. 6	385	14. 2	23. 2
Other areas [e]	3, 445	18	5. 2	9. 6	437	12. 7	26. 4

[a] Adapted from *Offshore Magazine.*

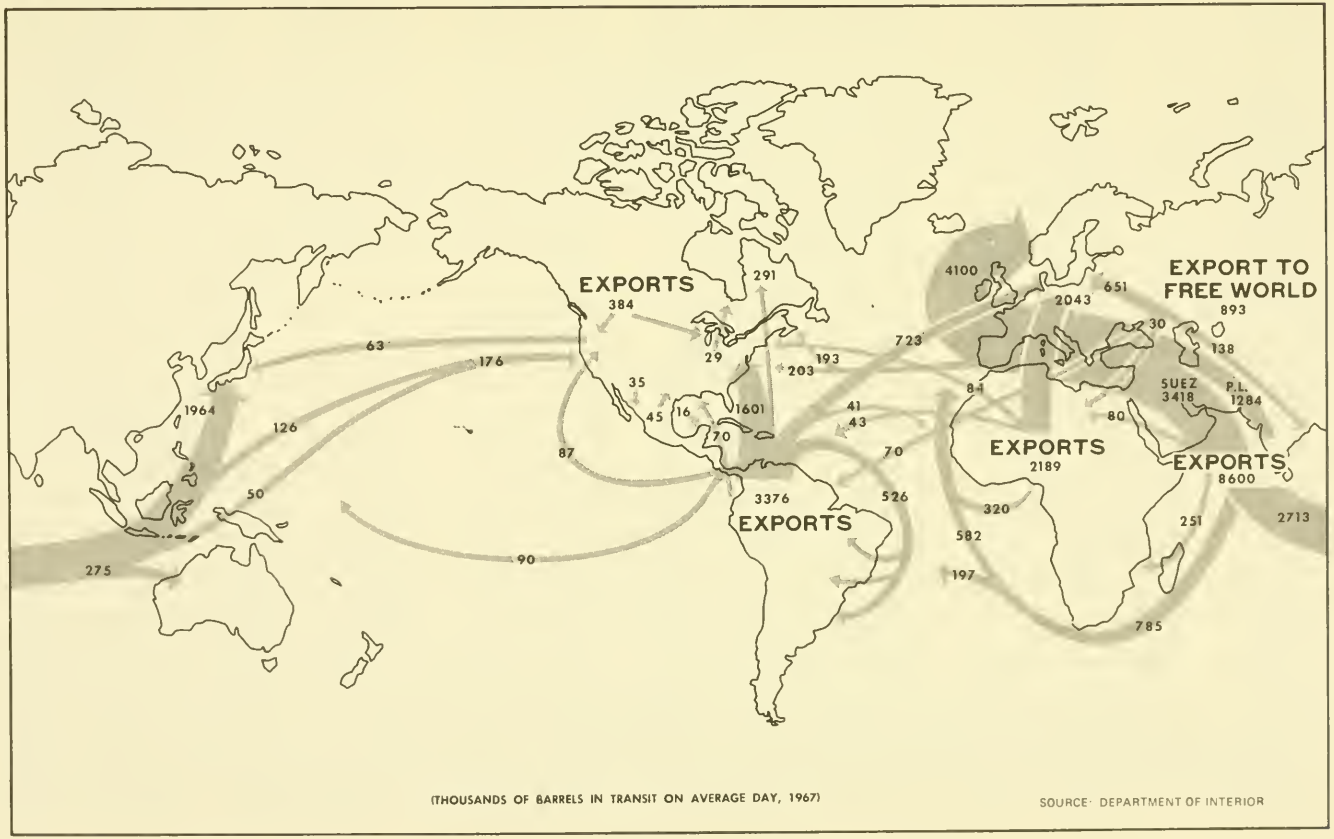
[b] Areas to depth of 1000 feet of water.

[c] "Excellent Potential" rating is given to areas containing or in continuity with excellent producing areas and with like geology.

[d] "Fair Potential" rating is given to areas containing or in continuity with fair producing areas, or when geology is similarly favorable for commercial production.

[e] Includes Europe, Africa, Far East, Oceania, and Antarctica.

Figure II–12—International Flow of Petroleum, 1967



tion totaled 1.63 trillion cubic feet, slightly less than 6 percent of Free World demand. Ten years ago only five countries conducted offshore drilling; today over 80 countries are interested in the resources of their Continental Shelves.

Income to the Federal Government derived from offshore leases and royalties is discussed in Chapter VII.

The demand for minerals is also increasing rapidly. The U.S. domestic demand for many minerals is expected to double by 1985 and perhaps triple by 2000. Between 1966 and the year 2000, world consumption of non-fuel minerals may increase five-fold. Competition for the world's mineral resources will become more intense as industrialization of the developing countries progresses.

While the mineral industries of the United States are among the most heavily capitalized and technologically advanced, the combination of high wage scales and depletion of high-grade domestic reserves of some minerals is making the United States a high-cost mining economy. In recent years domestic mining industries have frequently encountered difficulty in competing with cheaper foreign sources of supply. Clearly, in the future, if mineral demands are to be satisfied without increase in market cost, larger quantities of some commodities will have to be imported. At the same time, in important instances, the United States produces minerals that compete successfully for markets abroad.

Cumulative U.S. and world demand versus U.S. and world reserves and resources for about 30 mineral commodities that may occur on the Continental Shelf is depicted in Table II–6. It is evident from these data that new sources of supply for many mineral commodities will be needed to meet the projected demands and insure the security and economic viability of the United States.

The oceans represent such a potential source. Extensive deposits of phosphorites; metalliferous muds rich in copper, zinc, and other metals; manganese nodules containing cobalt, nickel, and copper; gold, tin, platinum, and other heavy minerals; and sand and gravel exist on and beyond the Continental Shelf. But present knowledge of the extent of these resources and their distribution is limited.

The growing worldwide demand for resources, the unexplored areas of the Continental Shelf with geological continuity with adjacent land areas which have yielded mineral wealth, and the scattered positive indications that resources exist, all direct attention to learning more about non-living resources under the sea. The Continental Shelf is thus a logical focus for a new era of systematic surveys to determine the presence, distribution, and richness of seabed deposits.

Figure II–13—Worldwide Offshore Drilling Activity

326-496 O—69——4

Table II-6—United States and World Land Reserves and Resources of Some Metals and Nonmetals That Occur on the Continental Shelves

Commodity	Minable reserves [a]		Resources [b]		Projected cumulative demand, 1966–2000 (rounded from Bureau of Mines estimates)	
	United States	World (including U.S.)	United States	World (including U.S.)	United States	World (including U.S.)
Aluminum (bauxite, millions, long tons)	45	5,800	300	9,600	[f] 440	840
Beryllium (short tons, equiv. beryl)	[c]	[c]	1,000,000	1,650,000	360,000	540,000
Chromium (millions, long tons, chromite)	0	2,000	8	[c]	22	74
Copper (millions, short tons)	86	210	65	[c]	[f] 140	400
Cobalt (thousands, short tons)	50	2,200	[c]	[c]	600	1,300
Gold (millions, troy ounces)	50	1,000	400	[c]	670	2,370
Industrial diamonds (million carats)	0	[c]	0	[c]	1,700	3,600
Iron ore (millions, long tons)	8,000	250,000	100,000	250,000	6,400	35,000
Manganese ore (millions, long tons)	0	3,800	1,000	15,000	50	450
Nickel (thousands, short tons)	250	60,000	1,400	[3]	[6] 14,500	31,700
Phosphate (millions, long tons)	12,000	48,000	48,000	[c]	500	2,000
Potash, (millions, short tons, K_2O)	1,400	72,000	5,000	[g]	300	1,100
Platinum group (millions, troy ounces)	3	280	[c]	[c]	[f] 144	250
Rare earths (millions, short tons)	5	[c]	[c]	5	.5	1
Silver (millions, troy ounces)	1,400	5,500	500	[c]	[f] 14,000	31,000
Sulfur (millions, short tons)	[c]	[c]	500	2,000	690	2,600
Tin (thousands, long tons)	9	5,600	43	11,400	[f] 3,200	9,200
Titanium (millions, short tons, TiO_2)	100	500	[c]	[d]	50	100
Thorium (thousands, short tons, ThO_2)	0	82	200	1,000	5	15
Tungsten (thousands, short tons)	70	1,500	200	[c]	620	2,040
Uranium (thousands, short tons, U_3O_8)	210	742	675	2,700	1,500	3,750
Vanadium (thousands, short tons)	200	3,500	1,300	20,000	650	1,000
Zircon (millions, short tons)	6	30	[c]	[c]	3.0	10

[a] Minable reserves are materials that may or may not be completely explored but that may be quantitatively estimated and are considered to be economically exploitable at the time of the estimate.

[b] Resources are materials other than reserves that are prospectively usable and include undiscovered recoverable resources as well as those whose exploitation requires more favorable economic conditions.

[c] Unknown. [d] Vast. [e] Several billion. [f] Demand figures include a significant quantity of recycled metal. [g] Very large.

Source: Department of Interior.

Intensified International Interest in the Oceans

Most of the world's 138 nations front on the oceans and are increasingly attempting to gain their stake in the sea. Many of these countries are new and developing and are entering the international ocean arena for the first time. All these nations—and the landlocked countries as well—are interested in the new possibilities the seas hold for improving their economies. With nations using the sea more intensively, national rivalries and conflicts could arise to inhibit the development of marine resources.

Mounting international interest and activity in the oceans are clearly reflected in the results of a U.N. poll last year of its member States requesting information on ocean activities. Of 58 nations responding to the questionnaire:

—52 were doing some basic or applied marine research;
—42 had nautical charting programs;
—16 operated position fixing systems or performed related navigational services;
—20 monitored or forecast physical ocean conditions;
—12 monitored and forecast pollutants;
—37 explored, monitored, and forecast fish stocks;
—21 undertook submarine geological and geophysical surveys; and
—19 were concerned with modifications of coasts and channels.

As to using the sea:

—45 engaged in fishing;
—9 exploited offshore petroleum and gas resources;
—14 used the ocean for recreation;
—13 exploited minerals from ocean water and the seabed;
—5 extracted sand and gravel from the sea;
—4 utilized the ocean for power; and
—7 disposed of wastes in the ocean.

The prospect of exploiting the seas has been magnified in the activities and discussions of the international community, particularly in the General Assembly of the United Nations, which is now a main focus for international ocean interest. The desire of nations to obtain membership on the recently created 42-nation U.N. Standing Committee on the Seabed and the unanimous U.N. endorsement of an expanded international program of ocean exploration with an increased role for the Intergovernmental Oceanographic Commission stirred unprecedented interest in the oceans last fall at the United Nations. Figure II–14 identifies the U.N. bodies with major responsibilities in the marine sciences.

As examples of the interest of nations in these activities, 55 countries participate in the activities of the FAO Committee on Fisheries, 60 countries are members of the Intergovernmental Maritime Consultative Organiza-

tion, and the membership of the Intergovernmental Oceanographic Commission has increased by 50 percent to more than 60 in less than three years.

Over the years men have learned to cooperate in using the seas, particularly in the use of nearby seas that influence several adjacent nations. Figure II–15 presents a selected group of intergovernmental regional organizations developed in recent years and now active in promoting cooperative marine activities. But the mounting interest of the world community, new technological achievements and new uses of the seas, and the changing political complexion suggest that the ocean may become more important than ever before as a source of national power and dispute. While the oceans can yield world-wide benefits, they can also create global havoc. Intensified ocean activities must be conducted within a framework of law and cooperation or they will inevitably lead to conflicts and debilitating rivalries.

New issues are emerging. Already, as shown in Appendix C–4, some coastal States have asserted national jurisdiction hundreds of miles seaward, eroding the traditional freedom of navigation of the seas. As man moves into the deep oceans he encounters new questions of jurisdiction over the seabed, and he seeks new legal principles to guide its development and use. As high seas fishing stocks become accessible to more nations, tradition is giving way to internationally reached agreements. As use of the ocean increases, the chances of disturbing the natural balance of the seas multiply—particularly through pollution which acts to the detriment of all users.

Thus, a view of the oceans requires not only an appraisal of scientific and technological opportunities, but also an awareness of changing national relationships and interests. The accelerating pace of oceanic developments makes it necessary for nations to intensify their efforts to promote world understanding and peace, to reduce conflict and rivalry, and to advance world order through increased multilateral, regional, and bilateral cooperation in the oceans. This unique arena where the interests of nations converge offers multiple opportunities for cooperative endeavors, and in the years ahead increased use of the oceans will be to a very large extent dependent upon successful statesmanship.

A Shield and a Bond for National Security

A nation's strength springs from many sources—political, economic, military, and scientific—and all aspects of national growth in a sense contribute to national security. Historically the oceans have played important military roles as a shield for defense, a springboard for attack, and a lifeline for sup-

Figure II-14—U.N. Bodies With Responsibilities in the Marine Sciences

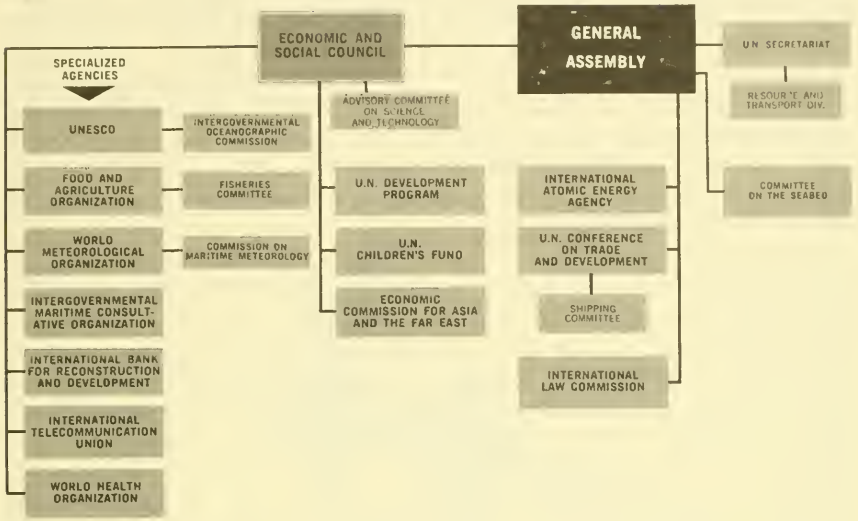
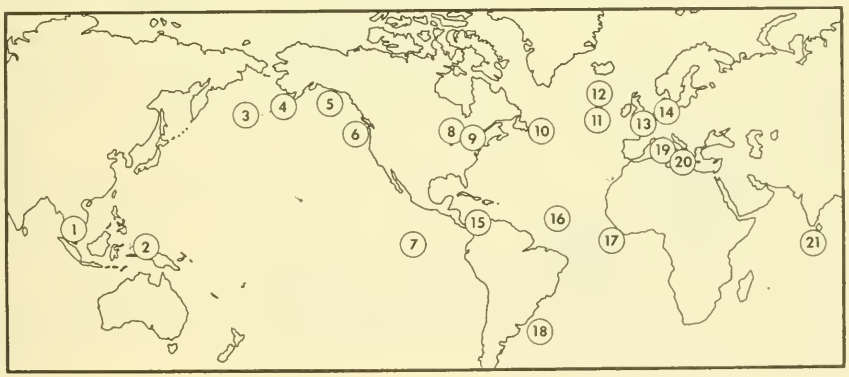


Figure II-15—Selected Intergovernmental Regional Organizations Active in Marine Sciences



1. Economic Commission for Asia and the Far East (Committee for Offshore Prospecting)
2. Indo-Pacific Fisheries Council
3. North Pacific Fur Seal Commission
4. International North Pacific Fisheries Commission
5. International Pacific Halibut Commission
6. International Pacific Salmon Fisheries Commission
7. Inter-American Tropical Tuna Convention
8. International Joint Commission
9. Great Lakes Fishery Commission
10. International Commission for the Northwest Atlantic Fisheries
11. International Council for the Exploration of the Sea
12. North East Atlantic Fisheries Commission
13. Organization for Economic Cooperation and Development
14. North Atlantic Treaty Organization (Science Committee)
15. Organization of American States
16. International Commission for Conservation of Atlantic Tuna (not yet established)
17. Fisheries Committee for the Eastern Central Atlantic
18. South West Atlantic Fisheries Advisory Commission
19. International Commission for the Scientific Exploration of the Mediterranean Sea
20. General Fisheries Council for the Mediterranean
21. Indian Ocean Fishery Commission

port. Naval power has long been a primary source of military strength and a strong arm of foreign policy. The use of the seas by nations has, to a large extent, been directly related to the development of effective naval forces.

Since the earliest days of this Nation, naval activities have played an important role in our security. Long coastlines expose our flanks to the seas on both sides of the continent. Wide ocean expanses have separated us from many of our allies and our adversaries. Strength at sea has long been one of the cornerstones of U.S. collective security arrangements, some of which are depicted in Figure II–16.

Today's Navy has several primary missions—to provide a strategic deterrent, to help prevent and contain limited wars and, when needed, to support diplomatic activities. To carry out their missions, U.S. sea-based forces provide capabilities for deployment of submarines armed with nuclear missiles, anti-submarine operations, amphibious operations, bombardment and air support for ground operations, operations to protect essential shipping, and ocean surveillance. Figure II–17 illustrates recent naval support of U.S. responses to incidents abroad.

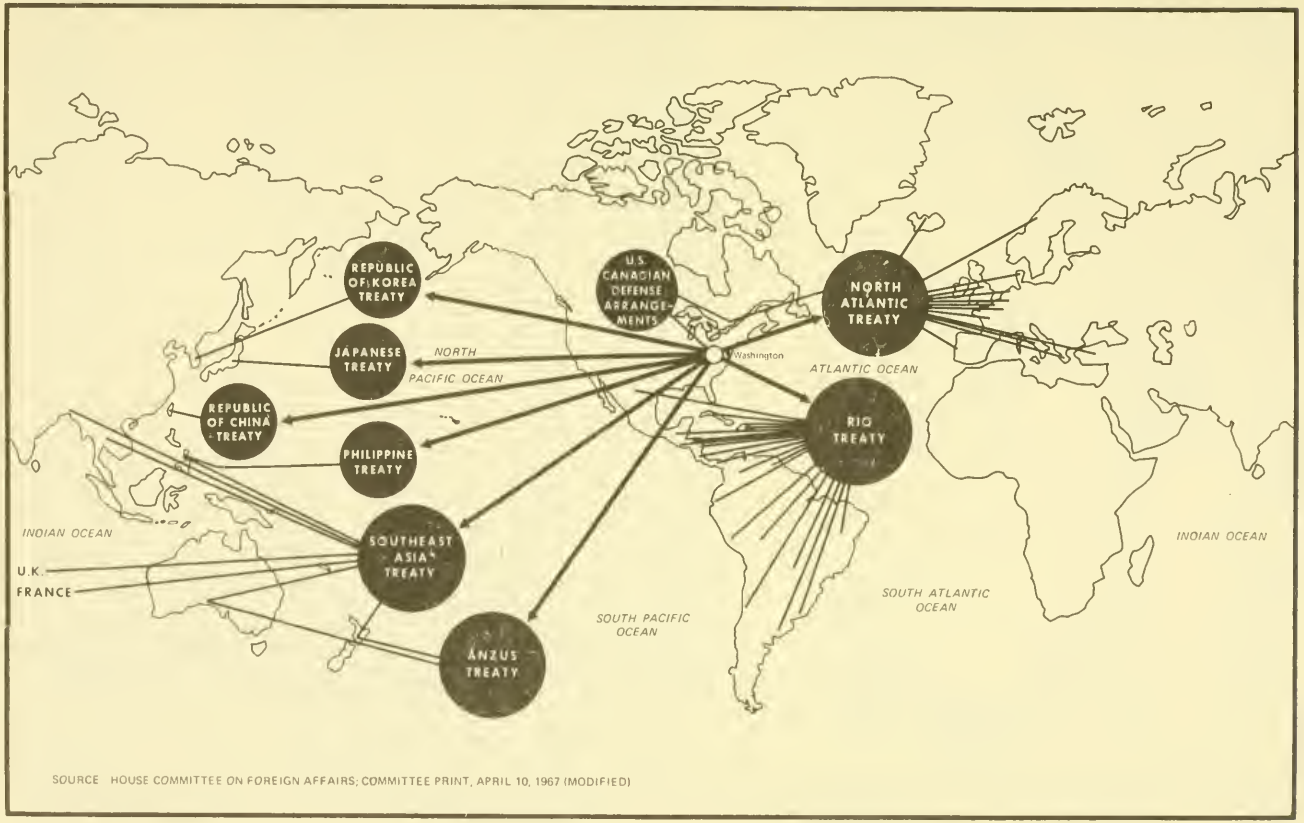
The size and prestige of the U.S. and Soviet Navies should not obscure the existence of many other fleets. As summarized in Table II–7, 10 countries have aircraft carriers; 15 possess cruisers; and more than 30 have destroyers. More than 40 new coastal nations have emerged since World War II, and the purchase of patrol boats and corvettes by many of them underscore the importance attached to a military presence on the seas. In the years ahead the submarine is likely to play an even greater role than now in carrying forth the Navy's mission. The Soviet Union and Mainland China have both expanded their submarine forces, and a number of the developing nations are acquiring older submarines to enhance their naval stature.

The effectiveness of naval operations—on, under, and above the sea—critically depends upon a total weapon system capability, including effective navigation systems, command and control systems, detection and tracking systems, and the weapons themselves. The achievements of the U.S. Navy in the marine sciences are essential in providing its fleet with the necessary technological base in all of these areas. The navies of many countries seek a similar capability.

Exploring New Frontiers

For man to use the ocean, he must understand it. Before he can fully accomplish the tasks outlined above—increase the sea's food output, extract its fuel and minerals, improve conditions in the Coastal Zone, forecast the weather, or enhance world security and peace—he must study and explore

Figure II–16—U.S. Participation in Collective Defense Arrangements



SOURCE: HOUSE COMMITTEE ON FOREIGN AFFAIRS; COMMITTEE PRINT, APRIL 10, 1967 (MODIFIED)

Figure II–17—Navy Support of U.S. Response to Incidents Abroad

1. 1946 A Navy force visited Athens to assist the Government of Greece.
2. 1948–1949 During the Berlin Airlift, naval tankers and supply ships carried large quantities of aviation gasoline to Bremerhaven, Germany, to support the Airlift.
3. 1950–1955 Large naval units carried allied forces overseas to help sustain South Korea, maintain control of adjacent waters, and provide air and gunfire bombardment and logistic support.
4. 1954 The Navy assisted in evacuating hundreds of thousands of refugees from North to South Vietnam.
5. 1955 At the request of the Republic of China, the Seventh Fleet evacuated troops, civilians, and tons of material from the Tachen Islands off the Chinese mainland.
6. 1956 The Sixth Fleet evacuated American and allied nationals when the Suez-Middle East situation became critical.
7. 1957 The Sixth Fleet deployed in the eastern Mediterranean to support Jordan.
8. 1958 The Sixth Fleet lifted and provided air cover for 1,800 Marines who were landed near Beirut at the request of Lebanon.
9. 1959–1960 Seventh Fleet units were alerted near Laos to render assistance to the U.N. Fact Finding Commission.
10. 1960 At the request of Nicaragua and Guatemala, Navy warships and aircraft were positioned to provide assistance.
11. 1960–1961 Atlantic Fleet units transported U.N. troops to quell civil disorder in the Congo and carried emergency supplies to relieve starvation.
12. 1961 Supported by large Navy task forces, the U.S. began a long-term buildup of strength in South Vietnam to deter aggression there.
13. 1961 When East Germany erected the Berlin Wall, the Navy activated Reserve ships and men to meet possible crises.
14. 1962 The Atlantic Fleet quarantined Cuba and continued surveillance operations until the quarantine was lifted.
15. 1963 Navy forces went to the Caribbean when the Dominican Republic threatened to invade Haiti endangering U.S. citizens.
16. 1964 The *Maddox* and *Turner Joy* destroyed attacking North Vietnamese PT boats in the Gulf of Tonkin.
17. 1965 The Navy stood by to evacuate U.S. citizens from the strife-torn Dominican Republic.
18. 1965–1968 The Navy is assisting allied forces to enable South Vietnam to maintain its independence.

the world oceans. But to some extent exploration and research are also a purpose themselves. Each of us has a latent curiosity about the world around him, and scientific discovery becomes a purpose of society—at least of the affluent societies. Indeed exploration, science, and invention are a feature of American culture.

As shown in the list of exploration milestones in Table II-8, great strides have been made in recent years in surveying distant ocean reaches. But we have only begun to venture into the vastness of the seas. Knowledge of the ocean and its resources is exceedingly limited. Because of the very size, complexity, and variability of the marine environment, scientific investigations of vast scope will be required if knowledge of this environment is to increase within a reasonably short period.

World interest in the oceans is growing and nations are moving to strengthen their marine science capabilities—to extend their exploration capabilities. In the past few years a number of nations, including Canada, France, Germany, Japan, the United Kingdom, the Soviet Union, and the United States have made significant steps to increase their ocean and underseas research capabilities.

Perspective for the Future

We have only begun to realize the promise of the ocean. The preceding pages have described uses of the sea today, with a glimpse of uses tomorrow. In an environment where so little is known, and where technologies are in their infancy, it would be folly to attempt definitive long-range prediction. But it is clear that as the world's population grows rapidly, the sea can provide new sources of nutritious food. Untapped mineral and energy resources of the sea can help meet growing demands of the world's expanding economy. New understanding of the processes of the ocean—the great regulator of weather and climate—can benefit agriculture, shipping, travel, health, and recreation.

The following chapters discuss what the Federal Government is doing to meet these challenges.

Table II–7—World Naval

Country	Aircraft, escort, helicopter carriers	Submarines		Cruisers	Destroyers	Destroyer escorts, frigates	Corvettes	Patrol vessels, sub chasers
		Nuclear	Conventional					
Argentina	1		2	3	9	4	3	
Australia	2		2		9	10		
Belgium							2	
Brazil	1		4	2	9	6	10	
Bulgaria			2			2		8
Burma						1	2	5
Canada	1		4			23		
Ceylon						1		
Chile			2	2	4	1	2	2
China, Republic of					5	13	5	23
China (Mainland)			34		4	15		28
Colombia					3	2		
Cuba						4	2	14
Denmark			4			6	4	
Dominican R					2	3	5	7
Ecuador						3	2	
Egypt			13		6	3	3	
Finland						3		4
France	4		23	2	20	28		14
Germany (FRG)			12		10	24	7	
Germany (Soviet Zone)						4		41
Greece			3		8	4		13
India	1			2	3	14		
Indonesia			12	1	7	11	3	12
Iran					1	1	3	
Iraq								3
Israel			4		2	1		1
Italy			7	3	8	12	25	7
Japan			7		24	18		20
Korea (Republic of)					1	8	9	6
Korea (North)								15
Malaysia						1		
Mexico						8	21	1
Netherlands	1		6	2	12	8	12	
New Zealand						5		1
Norway			15			5		
Pakistan			1	1	5	2		
Paraguay								
Peru			4	2	2	3	2	
Philippines							6	6
Poland			11		5			8
Portugal			3		1	12	1	14
Rumania								3
South Africa					2	6		
Spain	1		8	1	18	8	6	2
Sweden			19	1	8	10		2
Thailand						5		14
Turkey			10		10		9	6
United Kingdom	7	5	43	3	22	71		
Uruguay						3		4
USA	56	80	127	37	378	284	10	40
USSR		50	350	20	120	100		300
Venezuela			1		3	6		12
Vietnam							6	2
Yugoslavia			4		3	3		2

Source: Jane's Fighting Ships, 1967–1968, edited by Raymond V. B. Blackman. Copyright (c) 1967 by Jane's Fighting Ships Publishing Co., Ltd. Used with permission of McGraw-Hill Book Co. These data include reserve fleet ships.

Fleets: Selected Categories

Gunboats, torpedo boats, fast patrol boats	Minelayers	Minesweepers	Motor launches, river gunboats	Landing ships and craft	Survey ships	Transport and supply ships	Oilers	Country
1	----------	10	----------	10	3	5	4	Argentina.
----------	----------	8	3	----------	2	----------	1	Australia.
----------	----------	46	7	----------	----------	----------	----------	Belgium.
----------	----------	4	11	----------	6	4	10	Brazil.
14	----------	30	----------	16	----------	----------	----------	Bulgaria.
5	----------	1	34	8	----------	1	----------	Burma.
----------	----------	6	3	----------	6	3	2	Canada.
----------	----------	----------	9	----------	----------	----------	----------	Ceylon.
4	----------	----------	----------	6	1	2	1	Chile.
48	1	13	50	83	2	6	5	China, Republic of.
226	----------	40	74	59	2	9	5	China (Mainland).
----------	----------	----------	22	----------	1	6	3	Colombia.
42	----------	----------	27	----------	----------	----------	----------	Cuba.
16	8	24	13	10	1	----------	2	Denmark.
----------	----------	----------	7	3	----------	----------	2	Dominican Rep.
----------	----------	----------	8	2	----------	----------	----------	Ecuador.
62	----------	8	----------	18	----------	----------	----------	Egypt.
13	2	5	14	----------	----------	9	----------	Finland.
----------	----------	101	13	19	9	26	10	France.
47	3	69	24	10	8	6	10	Germany (FRG).
52	----------	109	93	20	3	----------	3	Germany (Sov).
----------	2	19	5	23	2	----------	7	Greece.
----------	----------	6	13	2	4	----------	3	India.
64	----------	21	82	17	2	4	4	Indonesia.
----------	----------	6	24	3	----------	----------	2	Iran.
12	----------	----------	4	----------	----------	----------	----------	Iraq.
12	----------	----------	5	3	----------	----------	----------	Israel.
14	----------	61	----------	24	2	5	2	Italy.
10	2	47	32	10	----------	----------	2	Japan.
2	----------	12	----------	20	----------	7	4	Korea (Republic of)
21	----------	30	3	----------	----------	----------	----------	Korea (North).
4	----------	12	14	1	----------	----------	----------	Malaysia.
----------	----------	----------	8	----------	1	1	2	Mexico.
----------	----------	62	5	7	3	3	1	Netherlands.
----------	----------	----------	12	----------	1	----------	----------	New Zealand.
26	5	10	----------	----------	1	----------	----------	Norway.
----------	----------	8	6	----------	1	----------	2	Pakistan.
----------	----------	----------	8	----------	----------	----------	----------	Paraguay.
----------	----------	2	16	4	----------	3	4	Peru.
----------	----------	2	20	6	1	1	1	Philippines.
52	----------	22	17	17	1	----------	3	Poland.
----------	----------	16	35	4	6	----------	2	Portugal.
8	----------	26	----------	----------	----------	----------	----------	Rumania.
----------	----------	11	10	----------	1	----------	1	South Africa.
3	6	25	18	8	3	3	4	Spain.
43	11	38	24	12	12	1	3	Sweden.
----------	2	5	8	13	1	1	4	Thailand.
----------	7	21	30	----------	----------	----------	4	Turkey.
7	7	100	7	38	12	19	38	United Kingdom.
----------	----------	----------	----------	----------	1	----------	1	Uruguay.
10	14	176	264	246	26	165	75	USA.
450	----------	350	120	230	55	45	50	USSR.
----------	----------	----------	12	4	3	1	----------	Venezuela.
14	----------	3	----------	33	----------	1	2	Vietnam.
100	4	34	17	7	----------	2	6	Yugoslavia.

Table II–8—Selected Milestones in Ocean Exploration

INTERNATIONAL ACTIVITIES

Date	Program	Event
1949	Inter-American Tropical Tuna Commission.	First international cooperative mechanism for tuna research.
1950	Operation Cabot Gulf Stream Survey.	One of first international, multi-ship surveys.
1951	International Convention for the Northwest Atlantic Fisheries.	First meeting to enhance fisheries exploration and conservation.
1953	International North Pacific Fisheries Commission.	Japanese, Canadian, U.S. compact for oceanic research and fisheries regulation.
1955	Operation NORPAC.....	Japanese, Canadian, U.S. cooperative survey of North Pacific Ocean.
1956	Operation EQUAPAC....	Japanese, French, U.S. cooperative survey of Equatorial Pacific.
1957	International Council of Scientific Unions.	Establishment of Scientific Committee on Oceanic Research.
1958	Antarctic Treaty.....	Established framework for Antarctic activities, particularly polar research.
1957–1958	International Geophysical Year.	35 nation, 80 ship cooperative program of synoptic oceanographic observations.
1958–1960	Law of the Sea Conferences, Geneva.	Conventions reinforced principle of freedom of seas and provided broad framework for ocean activities.
1962–1965	International Indian Ocean Expedition.	23 nation, 40 ship cooperative, Indian Ocean research and charting activities.
1960	UNESCO Oceanographic Program.	Establishment of Intergovernmental Oceanographic Commission to coordinate international oceanographic activities.
1963	International Cooperative Investigation of the Tropical Atlantic.	7 nation, 14 ship study of seasonal abundance of living resources.
1967	International Convention for Investigation and Conservation of Atlantic Tuna Resources.	Preparation of convention to foster rational conservation and fishery development.
1967	Indian Ocean Fisheries Commission.	Promotes fishing exploration and development.
1967	Integrated Global Ocean Station System.	Initiation of international planning and coordination.
1967–1968	Operation EASTROPAC..	5 nation, 12 ship cooperative international study of large-scale, air-sea interactions and living resources.
1968	International Decade of Ocean Exploration.	U.N. General Assembly endorsement and steps initiated for national and international planning.

Table II-8—Selected Milestones in Ocean Exploration—Continued

NATIONAL ACTIVITIES

Date	Program	Event
1946–1952	Alaska King Crab Fishery	Exploration and development.
1947	Offshore oil production	First producing well drilled in offshore oil field off Louisiana.
1952	R/V *Hugh Smith*	Discovery and charting of subsurface currents leading to recognition of equatorial undercurrents as a permanent feature of oceanic circulation systems.
1954	Development of Outer Continental Shelf.	First Federal lease sale of Outer Continental Shelf lands off Louisiana.
1957	USCGC *Storis*, *Bramble*, and *Spar*	First deep draft transit of Northwest Passage in cooperation with Canada.
1958	USS *Nautilus*	First under-ice transit to North Pole.
1960	USS *Triton*	First underwater circumnavigation of the world.
1961	Bathyscaphe *Trieste*	First deep sea research vehicle to descend to bottom of world's deepest ocean trench. (35,800 ft.)
1961	Project Mohole	First successful deep ocean drilling experiment in water depth of 10,000 feet.
1962	FLIP	Experiments with first large stable deep ocean research platform.
1963	Data Monitoring by National Oceanographic Data Center.	First use of satellite communication for ship to shore relay of oceanographic data.
1963	R/V *Chain*	First operational use of shipboard general purpose computer.
1963	Location of USS *Thresher*	First successful effort in locating and identifying objects on the deep ocean floor.
1964	Oceanographic Buoy Development.	First use of radioisotopic power in unmanned oceanic weather buoy.
1964	R/V's *Conrad*, *Vema*	First use of satellite navigation by private oceanographic ships.
1964	NIMBUS I	First remote sensing of oceanic surface phenomena from spacecraft.
1965–1968	SEALAB Experiments	Manned underwater laboratories.
1968	*Glomar Challenger*	Discovery of indications of oil in Gulf of Mexico at depth of 11,700 feet.

"The dim, dark sea . . . that divides and yet unites mankind."

—HENRY W. LONGFELLOW

Chapter III

EXPANDING INTERNATIONAL COOPERATION AND UNDERSTANDING

The oceans are inherently international; they define the coastlines of more than 100 nations. Moreover, new ocean technologies are projecting national interests seaward as more countries become able to conduct maritime and naval activities farther from their coasts, exploit previously inaccessible ocean resources, and expand ocean exploration activities into distant seas and to deeper reaches of the seabed. As marine interests and operations of the nations of the world intensify and converge and competition for resources increases, international cooperation becomes essential to prevent and mitigate conflicts and rivalries and to foster world order and international economic development.[1]

Motivation for cooperative endeavors also lies in the need for more and better information about the sea. Many nations share experience and capabilities in marine science and technology. The United States—and all nations—can derive maximum benefit from this collective capability if nations share the responsibilities and the results of expanding ocean research.

[1] The increasing worldwide interest in marine sciences is reflected in the following five Council publications: "Marine Science Activities of the Nations of Africa," "Marine Science Activities of the Nations of East Asia," "Marine Science Activities of Canada and the Nations of Europe," "Marine Science Activities of the Nations of Latin America," "Marine Science Activities of the Nations of the Near East and South Asia." These and other Council publications are listed in Table XV–2 together with information concerning their availability.

Indeed, both because of the international character of scientific study of the seas and the common property aspect of deep ocean resources, a multinational approach to the peaceful uses of the seas is not only desirable but necessary.

In recognition of this need, the Marine Sciences Act gives special emphasis to international cooperation, including recognition of a leadership role of the United States.[2] Accordingly, the United States has sought to widen understanding of its plans to expand its activities under the Marine Sciences Act to encourage other nations to determine how the oceans could contribute to their development, and to promote collaborative endeavors by:

—encouraging increased cooperation among ocean scientists of all nations and broadened dissemination of scientific results;

—collaborating with other nations in developing and using new marine technologies within a framework of mutual benefit;

—strengthening the capabilities of the developing nations to use the oceans and their resources as pathways to economic progress, recognizing that assistance must be shared by other nations and international organizations;

—supporting activities of the many bodies of the United Nations system and other international organizations engaged in oceanic activities and efforts to improve the international organizational structure;

—strengthening international ocean programs and projects which foster cooperation among neighboring nations to meet common interests and problems;

—pursuing a strengthened code of international law which will preserve the traditional freedoms of the seas, insure that nations have equitable opportunities to participate in the development of the wealth of the oceans, and anticipate and prevent potential conflicts arising out of expanding maritime interests;[3]

—fostering international legal, financial, and political arrangements to promote investment in marine development and facilitate a fruitful partnership between public and private interests in marine matters;

[2] As international policy objectives, Section 2 of the Act states: "The preservation of the role of the United States as a leader in marine science and resource development." Also, ". . . The cooperation by the United States with other nations . . . in marine science activities when such cooperation is in the national interest." Section 6 of the Act states: "The Council, under the foreign policy guidance of the President and as he may request, shall coordinate a program of international cooperation in work done pursuant to this Act, pursuant to agreements made by the President with the advice and consent of the Senate."

[3] The following Council contract reports discuss many of the international law considerations: "Law for the Sea's Mineral Resources", "Fishery Policy and International Law", "International Legal Problems of Scientific Research in the Ocean". These and other reports prepared by contractors for the Council are listed in Table XV–3 together with information concerning their availability.

—encouraging mutual restraint among nations so that the oceans do not become the basis for military conflicts;
—considering questions of arms limitations on the seabed and ocean floor; and
—taking steps to reduce pollution and other activities which could adversely affect the ecological balance of the seas.

This policy framework reflects the distinctive contributions that ocean activities make to certain foreign policy goals: enhancing the prospects for a stable and lasting peace, curbing the growing economic gap between the developed and developing nations, strengthening regional cohesiveness in many areas of the world, and providing new sources of critically needed protein for an expanding world population. Steps taken internationally to advance these policies have included visits by senior U.S. officials abroad, conferences with foreign visitors, and support of numerous international activities.

Developing a Legal Regime for the Seabed

The most potentially far reaching international issues considered by the Marine Sciences Council during the past year were the International Decade of Ocean Exploration, described in detail in Chapter IX, and the legal status of the seabed of the deep ocean. Following the introduction of a proposal by Malta in the fall of 1967, the U.N. General Assembly undertook an "Examination of the question of the reservation exclusively for peaceful purposes of the seabed and the ocean floor, and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction, and the use of their resources in the interests of mankind." The United States actively participated in the debate.[4]

On December 18, 1967, the General Assembly established an Ad Hoc Committee of 35 members to prepare a study on the peaceful use of the deep ocean floor, including:

—a survey of past and present activities of the U.N. and its related agencies and other intergovernmental bodies with regard to the deep ocean floor;
—a survey of existing international agreements concerning the seabeds:

[4] The position taken by the United States followed the course set by President Johnson in July 1966 when he said: "Under no circumstances, we believe, must we ever allow the prospects of rich harvest and mineral wealth to create a new form of colonial competition among the maritime nations. We must be careful to avoid a race to grab and to hold the lands under the high seas. We must ensure that the deep seas and the ocean bottoms are, and remain, the legacy of all human beings."

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—an account of the scientific, technical, economic, legal, and other aspects of the deep ocean floor; and
—an indication regarding the practical means to promote international cooperation in the exploration, conservation, and use of the deep ocean floor.

The Ad Hoc Committee met three times during 1968, and considered background papers prepared for the Committee by the U.N. Secretariat, the Intergovernmental Oceanographic Commission (IOC), and other U.N. specialized agencies. Its final report illuminated many of the emerging conflicts of interest and reflected a heightened awareness of the technical and legal problems associated with exploiting the deep ocean floor. Expectations of early and large returns from resources of the deep seabed became tempered with realism.

During the fall of 1968, the General Assembly reviewed the Committee's report, and after extensive debate in the Political Committee of the General Assembly three Resolutions cosponsored by the United States were adopted. The Resolutions:

—establish a 42-member Standing Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction, which will expand the studies carried out earlier by the Ad Hoc Committee;
—urge measures to prevent pollution of the oceans; and
—support the U.S. proposal for an International Decade of Ocean Exploration within the framework of a comprehensive long-term program of scientific investigation and call on the IOC to play a leading role in coordinating the program.

The General Assembly also adopted a fourth Resolution which requested the Secretary General to study the question of establishing international machinery to promote exploration and exploitation of seabed resources and their use; the United States considered this proposal premature and therefore abstained.[5]

During the deliberations of the General Assembly and the Ad Hoc Committee, the United States submitted a number of additional proposals, including (a) a draft Resolution containing a declaration of principles on the use of the deep ocean floor; (b) a draft Resolution referring to the Eighteen Nation Disarmament Committee the question of arms limitations on the seabed and ocean floor with a view to defining those factors vital to a workable, verifiable, and effective international agreement which would prevent the use of this new environment for the emplacement of weapons of mass destruction; and (c) a suggestion to establish international marine preserves, i.e., major types of unmodified ocean habitats such as a deep

[5] These four Resolutions and the 1967 Resolution establishing the Ad Hoc Committee are included in Appendix C–1.

trench, an atoll, or a group of table mounts, to serve as ecological baselines and as areas for scientific research. The United States also supported a less extensive declaration of principles submitted by a number of delegations.[6]

In setting forth our position, the United States called for action looking toward international agreement that there is, and will remain, an area of the seabed and deep ocean floor beyond national jurisdiction. Taking into account the Geneva Convention of 1958 on the Continental Shelf, there should be established, as soon as practicable, an internationally agreed precise boundary delineating the area beyond national jurisdiction. Exploitation and use of the natural resources of the seabed and ocean floor prior to the establishment of a boundary should not prejudice the location of that boundary.

With regard to the regime for the area beyond national jurisdiction, the United States also took the position that no State should claim or exercise sovereignty or sovereign rights over any part of the area, and the area should not be subject to national appropriation by claims of sovereignty, by use or occupation, or by any other means. There should be no discrimination in the availability of the area for exploration, scientific research, and use by all States and their nationals. The U.S. position also asserts that internationally agreed arrangements governing the exploitation of resources of the area should be established as soon as practicable. Such arrangements should include provision for the orderly development of resources; conditions conducive to making of investments; preserving the integrity of investments in the area made prior to agreement on such arrangements; the dedication as feasible and practicable of a portion of the value of the resources recovered from the deep ocean floor to world and regional community purposes; and accommodation among the commercial and other uses of the deep ocean floor and marine environment.

Finally, the United States expressed the view that the seabed and deep ocean floor beyond national jurisdiction should be used exclusively for peaceful purposes in accordance with the U.N. Charter. Since this does not preclude military activities generally, specific limitations on designated military activities will require the negotiation of a detailed arms control agreement. Military activities not precluded by such an agreement would continue to be conducted in accordance with freedom of the seas and exclusively for peaceful purposes.

The development of these principles and further evolution of policy regarding jurisdiction over the deep seabed involve a number of considerations of national interest—security, economic growth, incentive for private investment, balance of payments, scientific research, aid to developing nations, and others. These diverse interests find their advocacy in different departments

[6] The draft Resolutions and the less extensive declaration of principles are included in Appendix C–2.

of the Federal Government. Conflicts in viewpoint are inevitable. To assist in formulating consistent Government-wide policies of international interest the Committee on International Policy in the Marine Environment was established by the Secretary of State at the request of the Vice President to examine the major international ocean policies. The Marine Sciences Council has requested all agencies to consult with the Department of State before undertaking any seabed activities which could have international implications. For example, the Departments of State and the Interior consult in advance on the issuance of offshore oil and gas permits and leases with possible international implication.

The Council has also consulted with the Arms Control and Disarmament Agency concerning positions relating to seabed arms control.

Because future international arrangements for the deep ocean floor will have an important effect on a variety of public and private interests, and to insure that all interests are given full consideration, the Government, in the continuing development of its position, has sought the views of representatives of the mineral, petroleum, maritime, and fishing industries, scientists and scholars, and others with special qualifications. Also, concerned Members and Committees of the Congress have been regularly consulted by the Department of State and other agencies.

Broadening Marine Science Activities of the U.N. Agencies

Many of the U.N. bodies in which the United States participates have expanded their marine science activities [7] to deal on a global scale with the same variety of maritime functions and issues with which the U.S. Government deals within its separate agencies. Internationally, however, no single organization provides a complete overview of ocean activities, although the U.N. General Assembly partially assumes that role.

Two reports were issued by the U.N. Secretary General in 1968 in response to Resolutions introduced by the U.S. and adopted by the Economic and Social Council (ECOSOC) and the General Assembly in 1966. The first report on Resources of the Sea describes the potential of marine mineral resources and marine food resources other than fish. The second report povides a comprehensive survey of the current status of marine science and technology of the individual U.N. members, with a number of specific recommendations to further international cooperation in this field.

[7] The Council will soon release a report, "International Marine Science Organizations," which briefly describes the activities of the many concerned international organizations.

Following consideration of these reports, ECOSOC unanimously adopted three Resolutions concerning marine science and technology calling for continuation and expansion of the studies of the Secretary General, urging international cooperation in strengthening education and training in marine science and technology, and inviting General Assembly endorsement of expanded cooperation including the International Decade of Ocean Exploration.[8]

Similarly, after debate in the Economic Committee the General Assembly welcomed the reports of the Secretary General and adopted two Resolutions which

—endorse the concept of a coordinated long-term oceanographic research program and request the U.N. Secretary General to consider a comprehensive program based on recommendations of the IOC and other interested international organizations; and

—call for increased international cooperation in developing, exploiting, and conserving living marine resources.

Central to the recommendations of the Secretary General was the recognition of the need to intensify the activities of the IOC to enable it to serve as a focal point for coordinating international marine science activities, in cooperation with other interested international organizations, and particularly the Food and Agriculture Organization (FAO) and the World Meteorological Organization (WMO). The United States and other nations have made specific suggestions for increasing the resources available to the IOC and for restructuring the organization, and these proposals will probably be acted on in 1969.

The IOC, with U.S. participation, expanded its activities significantly in 1968 and improved working relations with a number of organizations. Planning began for several new ocean surveys: an International Coordination Group for the Southern Ocean study was formed; the first meeting of the International Coordination Group for the Cooperative Investigation of the Caribbean and Adjacent Regions was held in Curacao; procedures were developed for cooperating with the International Council for the Exploration of the Seas and the International Commission for Northwest Atlantic Fisheries; and planning began for study of the Mediterranean in cooperation with the General Fisheries Council for the Mediterranean of the FAO and the International Commission for the Scientific Exploration of the Mediterranean Sea. New IOC Working Groups considered legal aspects of oceanographic research including a draft resolution to advance fundamental scientific research for consideration by the IOC in 1969 and

[8] The text of the U.N. and ECOSOC Resolutions of 1968 are presented in Appendices C–1 and C–3.

developed the initial framework for the Integrated Global Ocean Station System (IGOSS).[9]

The WMO Executive Committee established a Panel on the Meteorological Aspects of Ocean Affairs to provide guidance on ocean activities generally and to provide coordination with IOC, especially in implementation of IGOSS. The WMO Commission on Maritime Meteorology called for expanding international cooperation in the exploration of the ocean.

The Intergovernmental Maritime Consultative Organization (IMCO) took steps toward amending the 1960 Convention on Safety of Life at Sea and preparing recommendations to member governments designed to improve safety measures and prevent pollution of the seas. IMCO also considered measures which would authorize coastal State actions on the high seas to prevent pollution, but progress in developing recommendations regarding the responsibility of shipowners or cargo owners for costs of cleaning up pollution has been slow.

The FAO supports a broad range of fishery projects in the developing countries. These projects far exceed the scope of similar projects supported through bilateral and other multilateral channels. The extent of the U.S. contribution to these FAO projects is indicated in Table III–1. The FAO's Committee on Fisheries proposed in 1968 as a further step that its six regional fisheries bodies develop specific regional research and development projects which could be presented to various multilateral funding agencies including the U.N. Development Program.

The U.N. Economic Commission for Asia and the Far East accelerated investigations of the Continental Shelf of four Asian nations, and U.S. Navy aircraft provided support for geomagnetic surveys.

Cooperating on a Regional Basis

Marine science and technology offer many opportunities for regional cooperation which can strengthen scientific and economic capacities and promote regional economic development and political stability. Therefore, the United States is fostering regional cooperation through bilateral and multilateral arrangements and through the regional activities of the U.N. family of organizations.

In Europe, regional marine programs can potentially contribute to strengthening Atlantic alliances, furthering economic integration of Western Europe, and quickening progress in East-West relations. The NATO Science Committee's Ad Hoc Study Group on Oceanography has recently

[9] IGOSS is contemplated as a world-wide system for observing the marine environment, communicating and processing the data, and disseminating the products in real-time for use by marine interests. IGOSS would be closely related to and coordinated with the World Weather Watch Programs.

Table III-1—U.S. Contributions to Selected Intergovernmental Organizations for Marine Programs

(In thousands of dollars)

	FY 1968	FY 1969	FY 1970
Food and Agriculture Organization: [a]			
Regular Budget	811	1,025	1,025
U.N. Development Program	3,400	3,400	3,400
FAO Subtotal	4,211	4,425	4,425
U.N. Educational, Scientific and Cultural Organization: [b]			
Regular Budget	117	117	132
U.N. Development Program	77	114	114
UNESCO Subtotal	194	231	246
International Maritime Consultative Organization:			
Regular Budget	103	119	119
U.N. Development Program	79	79	79
IMCO Subtotal	182	198	198
International Hydrographic Bureau:			
Regular Budget	11	15	16
Total	4,598	4,869	4,885

[a] Fisheries Department.
[b] Oceanographic activities, including Intergovernmental Oceanographic Commission.

examined and recommended various new initiatives including an international buoy program, standardization of instrumentation, and a proposed manned platform on the Continental Shelf. Also, the Organization for Economic Cooperation and Development has established a permanent committee to consider the preservation of materials in the marine environment as a further stage in strengthening its role in marine sciences, and the European Economic Community has established a committee on oceanography.

As part of the action program looking to economic and social betterment in Latin America, the Presidents of the Americas, in their *Punta del Este Declaration* in April 1967, proposed that multinational technological and scientific training and research institutions at the postgraduate level be established, and that existing institutions be strengthened. The Secretariat of the Organization of the American States has proposed, *inter alia*, a multinational program in marine sciences, consisting of six projects: three involving postgraduate training and three directed to oceanographic research

with a suggested budget of $330,000 for the first year. These proposals are now under review.

International programs concerning the Great Lakes are discussed in Chapter IV.

Improving International Fishery Arrangements

The basic fisheries policy of the United States is to increase, consistent with sound conservation principles, the utilization of the living resources of the sea for the benefit of mankind. As a corollary, the United States seeks to insure freedom of access of all countries to the living resources of the high seas, subject to the obligation to apply effective conservation measures when needed. Recognizing, however, that a strict application of this principle may in some cases result in inequitable hardships for coastal fishermen, our policy provides in such instances for recognition of the special economic interests of the coastal State in fisheries beyond jurisdictional waters. Such recognition is an important element of U.S. proposals for solution of international fishery problems in various areas including the North Atlantic, the North Pacific, and the Southeast Pacific.

The United States actively participates in eight international fishery commissions identified in Table III–2. These commissions are responsible for research and management practices concerning fish stocks which provide an annual catch to U.S. fishermen valued at more than $200 million. Additionally a number of bilateral arrangements have been concluded concerning other fishery stocks. Among the many developments in 1968 within the commissions and bilateral arrangements were:

—continuation of agreements with the USSR and new agreements with Japan concerning king crab fishing in the Eastern Bering Sea, fishing gear conflicts off Alaska, fishing activities in the Northeastern Pacific, and cooperative fishery research projects in the Bering Sea; continuation of an agreement with the USSR concerning fishing off the mid-Atlantic States;

—an agreement with Mexico concerning fishing of each country in the fishery zone of the other and related fishery data exchanges and cooperative research programs;

—substantial increase in the quota for eastern Pacific yellowfin tuna;

—entry into force of comprehensive conservation regulations covering the entire area of the International Convention for the Northwest Atlantic Fisheries and consideration of a U.S. proposal to add economic and technical considerations to regulation of the fishery;

Table III–2—U.S. Contributions to International Fishery Commissions

International Fishery Commissions	President's budget, FY 1970 (In thousands of dollars)	U.S. Share of budget (percentage)	Approximate value of U.S. catch at fishermen's level (1957) (in millions of dollars)
International Pacific Halibut Commission	214	50	10
International Pacific Salmon Commission	386	50	6
Inter-American Tropical Tuna Commission	427	96	47
International Commission for the Northwest Atlantic Fisheries	7	7	90
International Whaling Commission	1	6	1
Great Lakes Fishery Commission	1, 063	68	6
International North Pacific Fisheries Commission	23	33	67
North Pacific Fur Seal Commission	4	25	5
International Commission for the Conservation of Atlantic Tuna [b]	10	(c)	(c)
Total [a]	2, 135		

[a] Includes small amount for travel expenses of U.S. Commissioners and their advisors.

[b] Not yet established.

[c] Not readily available.

—new programs of the International North Pacific Fisheries Commission of coordinated research on ground fish and crab resources of the Gulf of Alaska and Bering Sea; and

—agreement on effective conservation of North Pacific whales, and continuation of an agreed realistic quota for Antarctic whales.

New legislation (P.L. 90–482) included an amendment to the Fishermen's Protective Act to extend coverage of the Act to reimburse U.S. fishermen for license fees, registration fees, or any other direct charges in addition to fines imposed by foreign governments for fishing more than 12 miles from foreign coasts. The Act now provides that if any country which has seized an American vessel fails to make payment in full within 120 days after receiving notice of a claim, the Secretary of State shall withhold, pending such payment, an amount equal to such unpaid claim from any funds programed for the current fiscal year for assistance to the government of such country. Also, the Foreign Military Sales Act now provides that the United States cannot sell defense articles or services to any country that seizes or fines an American fishing vessel engaged in fishing more than 12 miles from the coast of that country. The Act permits a waiver by the President when he determines that the sale would be important to the security of the United States.

Fostering Bilateral and Multilateral Cooperation

Federal agencies support several hundred projects involving bilateral cooperation, including the following types of programs:

—accommodation of foreign oceanographers on U.S. research platforms and in U.S. laboratories;
—coordinated research projects involving U.S. and foreign ships;
—support of research conducted at foreign laboratories;
—support of U.S. scientists providing advice to foreign governments;
—training of foreign specialists at U.S. facilities in fishing technology, military oceanography, and safety at sea;
—cooperation in joint search and rescue missions;
—exchange of navigational aids and information;
—exchange of the right to reproduce foreign facsimile charts;
—technical assistance in surveying foreign harbors;
—magnetic aerial reconnaissance surveys of foreign coastal areas;
—support of regional marine specimen collection and sorting activities;
—joint studies of erosion, delta development, and other nearshore processes affecting the coastline; and
—risk guarantees for private fishery investment abroad.

In addition the United States participates in a wide variety of multilateral activities including:

—collection of environmental data through ships of opportunity;
—participation in the Pacific tsunami [10] warning system;
—broad dissemination of weather and ocean data including data acquired from satellites;
—conducting the International Ice Patrol;
—support of international banking loans for fishery and port development; and
—broadened collection and dissemination of hydrographic data and charts.

The United States has bilateral science agreements with Italy, Iran, and Australia for potential cooperation in marine science. The U.S.-Japan Agreement on Natural Resources has been explicitly expanded to include marine sciences. An informal understanding is under discussion between the Marine Sciences Council and France's counterpart, the National Council for the Exploitation of the Oceans (CNEXO), for cooperative efforts between U.S. and French specialists. During the recent visit to the United States of the Prime Minister of Barbados, the President noted the importance of a bilateral agreement for a major air/sea interaction experiment

[10] Seismic sea wave.

involving U.S. research ships, aircraft, spacecraft, and buoys 70 miles east of Barbados in 1969.

Among other 1968 highlights of our international cooperative endeavors were:

—Following Council review of the opportunities for foreign participation in the Navy's SEALAB III experiments, aquanauts from England, Canada, and Australia were invited to participate in the experiments and observers from 50 countries were invited to visit the SEALAB III site.

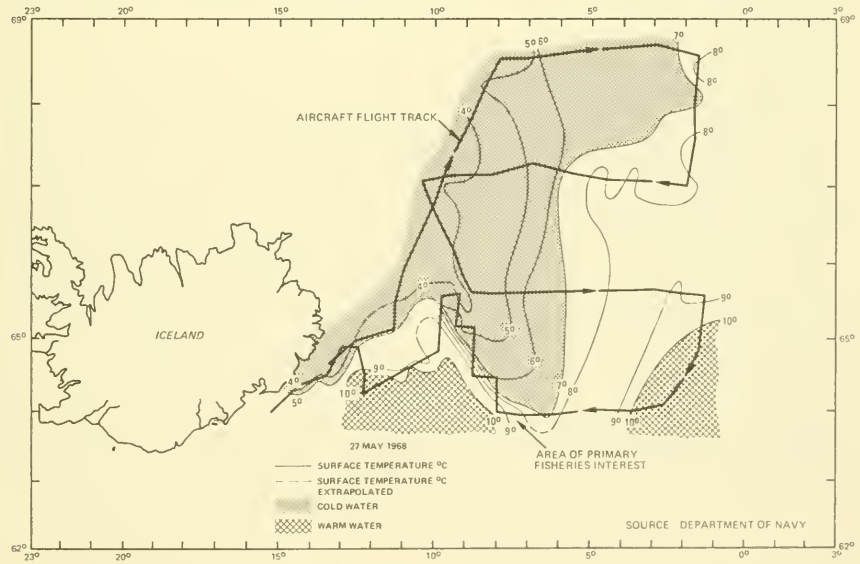
—The Navy has made available to foreign countries the technical specifications to permit modification of foreign submarines to mate with the Deep Submergence Rescue Vehicle described in Chapter V.

—Preparations were made for participation in the trade exhibit, Oceanology International '69, in Brighton, England, and for possible inclusion of an oceanographic exhibit in the U.S. pavilion at the Osaka World's Fair in 1970.

—Concurrently with efforts to stimulate foreign markets for U.S. oceanographic products, a review is being undertaken of regulations governing the export of American equipment.

—U.S. aircraft with remote sensing capability delineated the changing temperature pattern of the ocean surface layer which determines the location of herring resources vital to the Icelandic economy (Figure III–1).

Figure III–1—Location of Region of Fisheries Interest off Iceland



Seeking Future Opportunities

International attention is focusing sharply on a cooperative approach to the use of the oceans, and there are growing opportunities for our marine science programs to contribute to international understanding through (a) joint working projects, and (b) multilateral development of legal arrangements to prevent conflicts. Close consultations during the past year with many countries have demonstrated the broad common interest of the international community in strengthening collaborative efforts and in setting aside the oceans as an area free from conflict and dispute.

". . . *all Americans—of present and future generations—have a right to enjoy the shoreline experience.*"—REPORT OF THE PRESIDENT'S COMMISSION ON RECREATION AND NATURAL BEAUTY, "FROM SEA TO SHINING SEA"

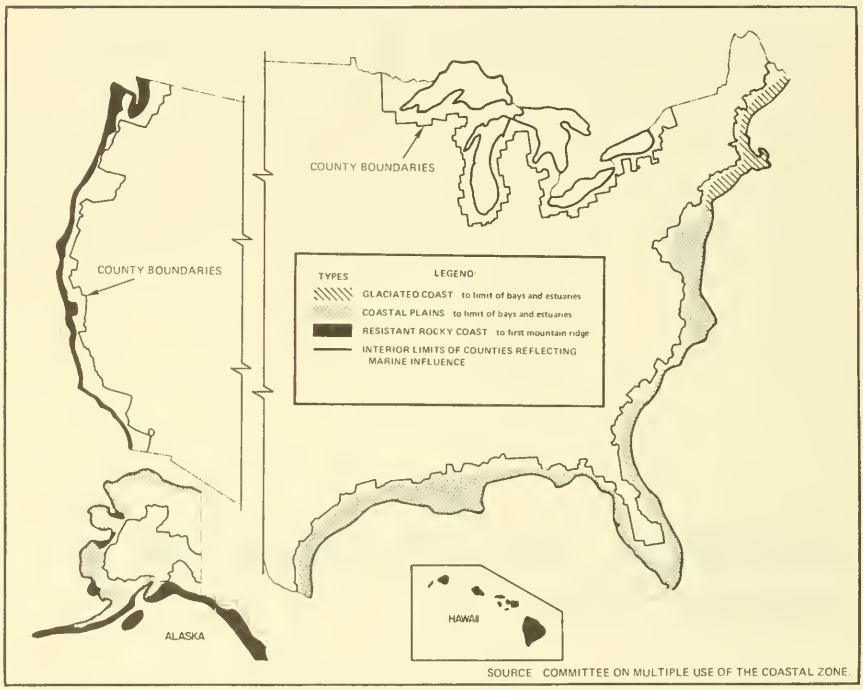
Chapter IV

ENHANCING BENEFITS FROM THE COASTAL ZONE

Thirty States, with more than 75 percent of the Nation's population, are on the coasts of the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Great Lakes. More than 45 percent of our urban population lives in coastal counties, and almost all of the major megalopoli now projected for the year 2000 are in the Coastal Zone—the margin where land and water meet and interact (Figure IV–1).

Shipbuilding, maritime commerce, and the fishing industry could have developed only in the Coastal Zone. Our naval strength and our seaward thrust for offshore oil, gas, and minerals must be based there. Many industries have found it advantageous to locate there because of proximity to ocean transport, labor, and product markets. With the demand for outdoor recreation increasing twice as fast as our burgeoning population, the American people increasingly seek the aesthetic benefits of the Coastal Zone—its

Figure IV–1—Landward Limit of the Coastal Zone



temperate climate and opportunities for swimming, sport fishing, and boating. Tens of millions live or vacation at coastal resorts, retirement homes, and beach cottages. Millions regularly head for beaches on weekends. Many others find business opportunities there. Figure IV–2 exemplifies the increasing demand for coastal recreation facilities.

Regrettably, any description of the Coastal Zone must also include a description of deterioration of the environment itself—by pollution of bays and estuaries, by hurricane damage and wave erosion, and by inadvertent human abuse of a fragile ecology that forms the habitat of important fish and wildlife. For example, the Coastal Zone is the most important habitat of domestic commercial fishery resources supplying 90 to 95 percent of the total U.S. catch; but our estuaries are being altered, directly threatening many of these valuable fishery resources.

The scope, diversity, and significance of activities in the Coastal Zone are so broad that practically all institutions of our society have become involved in its use and management—private individuals who own shoreland; industrial, conservation, and recreation interests; local and State governments; and the Federal Government. Despite obvious advantages, Coastal Zone lands and waters have only rarely been subjected to coordinated

Figure IV–2—*Shilshole Bay Marina in Puget Sound, developed jointly by the Port of Seattle and the Corps of Engineers, is typical of expanding recreational facilities in the Coastal Zone. The demand for such facilities exceeds their current availability; Shilshole is filled to capacity with 1250 boats, and more than 500 boatowners are on a waiting list for moorage.*

planning and controlled development. Further, the planning which has been done has not always resulted in effective allocation of resource uses among competitors. As a consequence, the trend has often been toward

single-purpose uses, determined by immediate economic advantages to individuals, firms, and local governments, without long-term or broader consideration of alternatives.

In the early stages of a shoreline's development, single actions may have relatively little impact on other potential users. But in time, the resource base for certain uses is dissipated. Expansion of private ownership and development has frequently reduced public access to beaches. The physical destruction of estuarine habitats by dredging and filling has often decreased a region's fishing potential; and the pollution of estuarine and coastal waters has begun to destroy much of their usefulness for water supplies, fish and wildlife, and recreation. What we seek are opportunities for multiple, compatible uses of our coastal ribbon and for maintaining as many options for future uses as possible. Science and technology can become tools to assist in accomplishing this goal.

Because of the diversity of Coastal Zone activities in which the Federal Government has a responsibility, almost every member and observer agency of the Marine Sciences Council is directly concerned with some aspect of the Coastal Zone. Figure IV–3 summarizes funding levels for Federal marine science activities in the Coastal Zone. Other components of the marine science program related to the Coastal Zone, such as fisheries, port and channel development, tidal prediction services, and basic research are discussed in other chapters. Detailed information on Federal funding for Coastal Zone activities is also presented in Appendices A–4, A–5, and A–6.

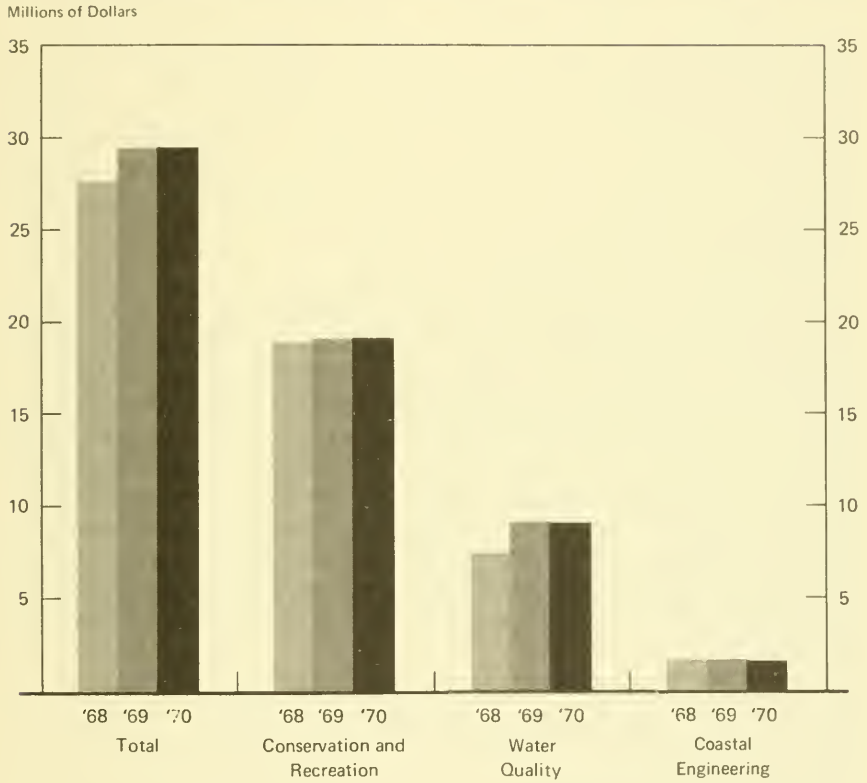
Significant advances in Federal activities require an interagency approach which has been reflected in the emphasis given the Coast Zone, including the Great Lakes, by the Council.

Opportunities for Conservation and Recreation

The National Park Service system now includes 20 areas contiguous with a coastline—11 national parks and monuments devoted to resource protection and nine national seashores and lakeshores for both protection and recreation. Biscayne National Monument in Florida and Redwood National Park, which includes a 30-mile stretch of the California coastline, were authorized for addition to the system by the 90th Congress. Other areas along the seacoast and the shores of the Great Lakes have been proposed or are under active consideration. Additionally, in 1968 the National Park Service participated in the following Federal surveys of potential conservation and recreation areas:

—the bioluminescent bays of Puerto Rico;
—the Canaveral Seashore at the Kennedy Space Center; and
—the Gulf Islands region of Florida, Alabama, Mississippi, and Louisiana.

Figure IV–3—Federal Funding for Marine Science, Use of Coastal Zone



The National Wildlife Refuge System includes 42 estuarine refuges, containing 18 million acres devoted to management programs for waterfowl and other wildlife, and particularly preservation of endangered species. Approximately 16,000 acres are scheduled for early acquisition for estuarine refuges under the accelerated Wetlands Acquisition Program.

During FY 1968, 8,000 acres of coastal land were set aside for public use pursuant to Federal programs. The Bureau of Outdoor Recreation plays a central role in promoting Federal-State cooperation and coordination in planning and in the acquisition of lands devoted to public recreation. A Nationwide Outdoor Recreation Plan will soon be completed and will provide a framework for Federal, State, and local and private outdoor recreation programs, including those directed to marine recreation. Also, an inventory of U.S. islands was completed and several thousand identified as having significant local, State, or Federal recreational potential.

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The Bureau administers the Land and Water Conservation Fund Act of 1965 which was amended last year to authorize use of revenues from the Outer Continental Shelf Lands Act to assist in assuring the availability of funds for Federal acquisition of recreational land and for grants to States for outdoor recreation.[1] A portion of these funds has been used to acquire land for public recreation within the Coastal Zone. All States have prepared comprehensive Statewide Outdoor Recreation Plans, many of which include provisions for meeting marine-related recreation needs and the preservation of significant coastal areas. Based upon these plans, the Bureau has assisted over 2,000 State and local outdoor recreation projects.

In recognition that more than 20 million people now participate in recreational boating in coastal waters, the Coast Guard has established an Office of Boating Safety which will emphasize equipment standards and increased Federal-State coordination. Also, the Coast Guard has established a membership goal of 100,000 for the Coast Guard Auxiliary by 1973—a four-fold increase. The Recreational Boating Safety Bill introduced last year reflects concern over the need to protect recreational boating participants while at the same time providing financial assistance to State boating safety programs. Among the research areas of particular concern are boat construction, fuel and ignition systems, operator visibility, and boat stability and load capacity. Also, ESSA provides small craft nautical charts and marine weather forecasts and warnings.

The activities of the Bureau of Commercial Fisheries in the Coastal Zone provide additional benefits for water-oriented recreation, including sport fishing and hunting, for management of fishery resources, and for contributing toward the long-range planning for multi-use development and management of the Coastal Zone. The Bureau assists other Federal agencies and States to assess proposed estuarine alterations to prevent damage to the fishery resources.

Two recent surveys published by the Bureau of Sport Fisheries and Wildlife illustrate the increasing importance of saltwater sport fishing. During 1965, 8.3 million anglers spent $800 million to catch 1.7 million tons of fish. The Bureau's research efforts in support of sport fishing include billfish tagging programs, preparation of an Atlantic marine fish atlas, and studies of predators.

The design for the National Fisheries Center and Aquarium, to be located in Washington, D.C., has been completed and construction is scheduled to begin in 1969.

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[1] P.L. 90–401 authorizes an annual appropriation of $200 million and provides for use of Outer Continental Shelf revenues to make up any difference between actual appropriations and $200 million.

Enhancing Water Quality

Water quality is one of the crucial determinants of the different uses of a coastal area. The Federal Water Pollution Control Act calls for the enhancement of the quality and value of the Nation's water resources and for the prevention, control, and abatement of pollution by establishment of water quality standards for interstate and coastal waters.[2] The Secretary of the Interior has given substantially complete approval to standards as developed by 45 States, Guam, the Virgin Islands, Puerto Rico, and the District of Columbia; standards for other States should also soon be approved.[3] Primary responsibility for enforcement of the standards, which vary with the nature of the area and the use of the water, rests with the States. If the States fail to act, however, the Federal Government may bring suit against polluters.

The Clean Water Restoration Act of 1966 (P.L. 89–753) provided for grants to States, municipalities, or intergovernmental bodies for assistance in developing projects to demonstrate advanced methods of waste treatment and purification and discharge control. The Act also provided for a comprehensive study of estuaries, including (a) the effects of pollution on various uses of these areas, and (b) the effects of population and economic development on water quality. Extensive public hearings have been held throughout the country. In addition the Act calls for recommending a national program for using estuaries, delineating the reponsibilities of the various levels of government, and clarifying public and private interests. The study has now reached the stage where the basic studies and analyses necessary to back up the formal report are commencing. The bulk of the contract data and the detailed report of State activities and organizations will soon be available. A National Estuarine Inventory is being developed and recorded on tape and will contain information on more than 850 estuaries. The report to the Congress is scheduled for November 1969.

Existing legislation provides the Corps of Engineers under the Refuse Act of 1899 and the Coast Guard under the Oil Pollution Act of 1961 with authority to act regarding certain kinds of water pollution.

Dozens of bills dealing with water pollution were introduced during the 90th Congress reflecting the nationwide concern over water quality.

[2] The Federal Water Pollution Control Administration administers the Act and engages in comprehensive planning, provides technical services, and participates in enforcement when necessary. Its programs in the Coastal Zone include technical assistance in pollution abatement and construction and planning grants. Several hundreds of millions of dollars are planned for the period FY 1968 through FY 1970. Although most of these public work funds are not included in the present definition of the national marine science program, these activities will have a major effect on the prevention of pollution in the Coastal Zone.

[3] Exceptions related primarily to water temperatures and dissolved oxygen.

However, the only coastal waters legislation adopted was P.L. 90-454, authorizing the Secretary of the Interior in cooperation with the States to conduct an inventory of the Nation's estuaries and their natural resources. Funding for the study has been requested. The Water Quality Improvement Act, proposed by the Administration but which failed to become law, would have provided for acceleration of construction of additional waste treatment facilities and extended pollution research programs. Another Administration bill, the Oil and Hazardous Substance Pollution Control Act of 1968, would have provided for the polluter to pay cleanup costs in certain instances.

Other developments in 1968 included:

—broadened investigations of the effects of thermal pollution by AEC and other agencies and consideration of legislation which would expand AEC's current regulatory authority related to thermal discharges from nuclear facilities;

—investigations by the Department of the Interior and Corps of Engineers of the effects of dumping sewage sludge, dredge spoil, and construction rubble in ocean dumping grounds off New York City; and

—23 research projects of the Office of Water Resources Research directed to a broad range of problems in the Coastal Zone.

Water quality of the Coastal Zone affects health in a number of ways: suitability of shellfish for human consumption, use of the Coastal Zone for recreational purposes, and use as a disposal site for wastes.

Activities of the Department of Health, Education, and Welfare concerning marine health problems include (a) conducting and supporting research, development, field investments, demonstrations, and pilot operations; (b) providing technical assistance to State and local programs; and (c) manpower training. Facilities serving the coastal areas are located in Alabama, Rhode Island, and Washington. Additional construction is underway or planned in the latter two States.

Improving Coastal Engineering Activities

Coastal engineering involves:

—shore protection and stabilization taking into account the dynamics of waves, their interaction with the shore and its structures, and the effect of hurricanes and storms;

—navigation works for harbors, ports, and waterways to facilitate movement of vessels; and

—tidal hydraulics including consideration of currents, circulation, and sediment movements in estuaries, inlets, and the Great Lakes.

Erosion is a common and often severe form of degradation of the coasts, caused by the action of tides, currents, and hurricane-induced storm surges and frequently aggravated by man's misuse of coastal lands. As a consequence, vast areas of valuable land have been essentially lost. Erosion may also introduce pollutants into the water, and the material deposited may clog navigation channels and suffocate marine life. Similarly, dredging for navigation is essential to waterborne commerce but can damage environmental quality—disturbing the habitat of marine or marsh life and affecting tidal circulation.

These deleterious effects can be controlled somewhat by shore stabilization and protection and by careful planning for channel and harbor construction, maintenance, and removal of hazards to navigation—long established functions of the Corps of Engineers. Traditionally, coastal engineering projects have been authorized and carried out one at a time in response to local requests. Recently, however, the Corps has adopted a longer-range approach to setting priorities for such public works.

The 1968 River and Harbor Act (P.L. 90–483) authorized the Corps to make a study of U.S. coasts to identify areas where erosion presents a serious problem, describe suitable remedial action, including preliminary cost estimates and priorities, and provide State and local authorities with information and recommendations concerning land use.

Research in tidal hydraulics seeks an understanding of the fundamentals of tidal circulation in estuaries, movement of sediments, and the physical effects of natural and structural changes. These conditions, such as the shoaling of an inlet and consequent reduced salinity of bay waters, cause drastic changes in estuarine ecosystems.

In addition to its own engineering programs, the Corps issues permits for private construction in navigable waters. Its original regulatory authority to protect navigation has been expanded to consider other possibly adverse environmental effects—through the Fish and Wildlife Coordination Act and subsequent interagency agreements with the Department of the Interior. This expanded authority is now being tested in the Federal courts. Should the courts find that Corps permits cannot be denied on grounds other than hazards to navigation, consideration of legislation to protect broader public interests may be warranted.

During the past year the Council endorsed a FY 1970 initiative of the Corps of Engineers, in cooperation with the Department of the Interior and other agencies, to expand efforts to assess the impact of water-related construction activities on coastal ecology. At the same time the Corps will accelerate its research efforts to develop new techniques and equipment for restoration of coastal shores, including more economical systems for moving offshore sand onto beaches. Figure IV–4 shows the results of one beach restoration project.

FEBRUARY 1965

JUNE 1965

Figure IV–4—*Two views of the southern portion of Wrightsville Beach, North Carolina, showing its eroded condition in February 1965 and the result of beach restoration by the Corps of Engineers four months later.*

Among the 1968 highlights of the Corps of Engineers research program were:

—completion of inventories of offshore sand deposits suitable for beach use off Florida, New Jersey, and New England and initiation of an inventory off the south shore of Long Island;

—development of erosion control techniques, including investigations of protective coatings of steel sheet pilings, low-cost sand-filled fabric bags for emergency protection from wave erosion, and experimental groin structures;

—laboratory and field studies of wave force effects on coastal structures;

—laboratory and field studies to improve design of navigation channels through tidal inlets;

—planning for new surveys of disposal of drift and other harbor debris and prevention of shore damage due to navigation projects (P.L. 90–483);

—development of criteria for the design of rubble-mound breakwaters and for determining wave impact forces on breakwaters; and

—development of criteria for the response characteristics of small boat harbors to the actions of short-period waves.

In addition, predictions of tides, currents, storms, and storm surges in relation to coastal engineering are carried out by ESSA. Related research on seabed soil mechanics is also being conducted by the Naval Civil Engineering Laboratory and by universities under contract with the Navy.

Encouraging Planned Use of the Coastal Zone

For the last two years, the Marine Sciences Council has considered that the multiple use problems of the Coastal Zone required urgent attention to improve coastal management policies and procedures and to identify more clearly the potential role of science and technology in assisting in the amelioration of conflicts. The Council therefore gave particular emphasis to Coastal Zone activities, with the assistance of its Committee on Multiple Use of the Coastal Zone.[4]

The following general approach has been endorsed by the Marine Sciences Council to assist in promoting optimal use of the Coastal Zone:

[4] Several Council contract reports have been very useful in identifying critical issues in resolving Coastal Zone conflicts and in providing background information: "Chesapeake Bay Case Study," "Shoreline Utilization in the Greater Seattle Area," "Legal Aspects of Coastal Land-Sea Interface," "Legal Aspects of Use of the Great Lakes," "Review of Use of the Coastal Zone of Lakes Erie and Superior." Also, a Department of Commerce study devoted to the interaction of the coastal economy and ecology has been conducted to aid regional planning commissions.

—strengthen planning and decision-making processes that rely on the expertise and knowledge of the coastal States, including the Great Lakes States, and are responsive to national as well as local needs;
—expand the structure for consideration of multi-State issues in Coastal Zone planning and management;
—broaden Federal policies and programs—without supplanting State autonomy and responsibility—to encourage the States to develop and carry out programs of planned use of the Coastal Zone in the national interest; and
—develop new mechanisms for acquiring, analyzing, and distributing management information and environmental data concerning the Coastal Zone.

This approach emphasizes that the State governments should be the focal points for planning and managing activities in the Coastal Zone, with the Federal and local governments supporting the States in carrying out this responsibility. In view of the inter-state character of many areas of the marine environment, each State should take into account the plans and needs of adjoining States, with the appropriate coordinating mechanisms depending on the region.

Already many Federal agencies support projects designed to foster development of the Coastal Zone. More deliberate coordination of these activities both at the Federal and State level is needed, supplemented as necessary by additional Federal encouragement of planning and management activities specifically directed to the Coastal Zone.

Strengthening Multiagency Programs

Based on studies by two interagency task forces to improve existing Federal programs and policies affecting the Coastal Zone, the Council recommended that the concerned agencies take further steps in six areas, namely:

1. Strengthening *policy planning, coordination, and development,* by:
—defining the national interest in the Coastal Zone more clearly and encouraging enunciation of national goals and objectives in Coastal Zone development by both the Executive and Legislative Branches;
—strengthening coordination of Federal agencies in the review of proposed Coastal Zone alterations;
—broadening studies of factors that influence land development in the Coastal Zone, possibly by a multidisciplinary panel of specialists on Coastal Zone development available for consultation with the States; and

—filling present planning gaps for making mass coastal recreation available near large congested coastal areas and identifying policy gaps in harbor waterfront restoration.

2. Resolving legal and other questions related to *Coastal Zone property, boundaries, and use,* by:

—clarifying the effect of manmade offshore structures on Federal-State boundaries;

—accelerating the delineation of domestic submerged land boundaries; and

—continuing efforts to minimize coastal interference between defense and other uses.

3. Assisting *commercial and sport fisheries,* by:

—examining the adequacy of laws governing commercial fishing between the seaward boundaries of the States and the limits of national jurisdiction;

—developing a model, scientifically-based, State law governing commercial fishing activity for consideration by the States in meeting problems unintentionally induced by archaic conservation measures; and

—developing a better system for collecting, processing, and disseminating statistics on commercial and sport fishing.

4. Enhancing *recreational and other uses* of the Coastal Zone, by:

—assisting the States in developing model legislation on coastal zoning;

—promptly identifying high value coastal areas essential for public use and considering a moratorium on disposal of "surplus" Federal land in the Coastal Zone; and

—seeking legislation to expand beach erosion and hurricane protection programs.

5. Maintaining the *quality of coastal waters,* by:

—enforcing water quality standards and other relevant laws to prevent further degradation of coastal waters;

—controlling ship-induced pollution in harbors and coastal waters;

—accelerating research to determine the significance and duration of the effects of major oil spills on marine animals and recreation; and

—devoting increased attention to reducing pollution from insecticides, herbicides, and fertilizers.

6. Encouraging *research, education, and information* development and dissemination, by:

—establishing coastal preserves for ecological research;

—establishing a central data bank for information and scientific data on Coastal Zone activities and conditions;

—encouraging training of Coastal Zone planners and managers under the Sea Grant Program;

—evaluating the need for a National Institute of Coastal Zone Studies;

—preparing a handbook to serve as a guide for local Coastal Zone development;
—developing information and legislation on preserving public access to the coast; and
—encouraging expanded research programs to quantify environmental effects of estuarine and coastal pollution.

Program for the Great Lakes

Because of rapid degradation of the Great Lakes with the exception of Lake Superior, the Council examined the role of numerous regional agencies currently engaged in Great Lakes planning and resource management to endeavor to develop a more coherent approach. Primary among such agencies are the Great Lakes Basin Commission, the Great Lakes Compact Commission, the Upper Great Lakes Regional Commission, the Great Lakes Fishery Commission, and the International Joint Commission. Despite the international nature of the Great Lakes and the importance of recognizing Canadian interests in any decisions affecting the Lakes, only the Great Lakes Fishery Commission and the International Joint Commission are international in character. Thus, the Council is encouraging steps to broaden the coordinating responsibility of the International Joint Commission in areas other than those under the purview of the Great Lakes Fishery Commission, with the U.S. section of the International Joint Commission strengthened accordingly.

Additionally, the Council reviewed steps of the Department of the Interior to assist in controlling the alewife population during the summer of 1968 and in developing a long-term alewife research and control program, and encouraged safeguards against pollution if oil production begins under Lake Erie.

A number of agencies, individually and collectively, supported the following activities during 1968:

—carrying out of a comprehensive study of the levels of the Lakes;
—completion of pollution control plans for Lakes Erie and Ontario, including an enforcement conference on Lake Erie;
—initiation of wave height forecasts four times per day;
—planning for an International Field Year on the Great Lakes with four projects: lake meteorology, energy balance, terrestrial water balance, and water movement;
—comprehensive review of dredging practices and effects of dredging on water quality;
—establishment of procedures for predicting wave level fluctuations induced by winds;
—study of legal aspects of Great Lakes resources; and

—request for FY 1970 funds to modify a Coast Guard tender to serve part time as an oceanographic research platform for scientists from Great Lakes universities and other institutions.

Also, P.L. 90–419 gives the consent of Congress to the eight-state Great Lakes Basin Compact, established to promote the "orderly, integrated, and comprehensive development, use, and conservation of the water resources of the Great Lakes Basin."

Multiple Use of the Chesapeake Bay

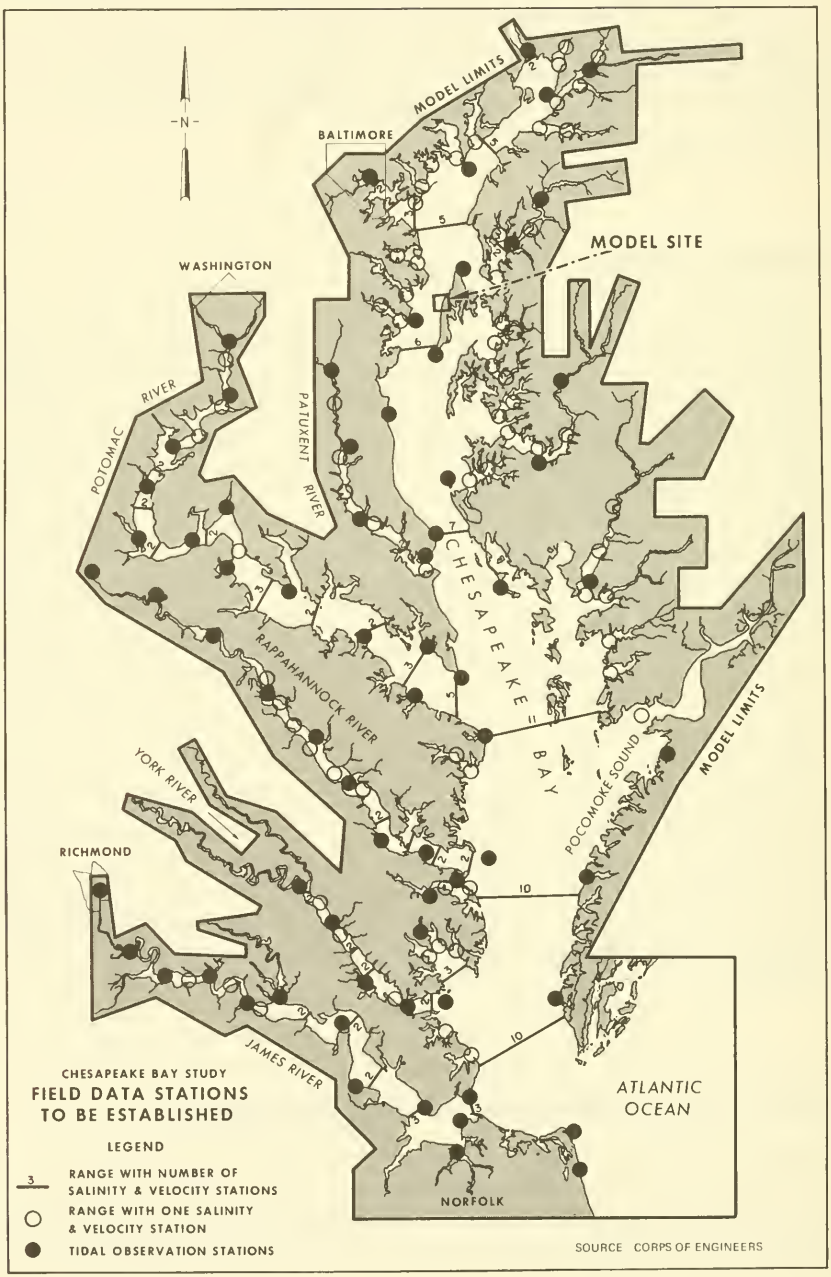
Since early 1967 the Council has been making a case study of the Chesapeake Bay, as it may furnish guidance for dealing with similar problems in other coastal waters. Multi-disciplinary research activities have been focused around a laboratory authorized for the Corps of Engineers for hydraulic and ecological studies that will employ a three-dimensional model of the Bay on a horizontal scale of 1:1,000. Figure IV–5 describes the geographical coverage and field stations that are planned. The model, supplemented by mathematical models and critical analysis, should improve and extend understanding of the physical and biological characteristics of the Bay and the effects of man's activities on the Bay environment. Of particular interest will be understanding of the capacity of the Potomac estuary to absorb pollutants. Projections will be made of the demands that increased population, economic, and industrial pressures will make on the land-water system of the Bay area.

At the same time it has been recognized that a more effective intergovernmental management system is needed to translate results of research and analysis into meaningful programs to permit orderly development of the Bay area without further degradation of its natural resources. Therefore, the Council has recommended consultations among all concerned interests at the regional, State, and local levels concerning the desirability, character, and composition of a possible intergovernmental commission for the Chesapeake Bay.

Need for a Strengthened Institutional Framework

We have noted the uniqueness of marine science affairs in the Coastal Zone resulting from intense, varied human uses superimposed on an intricate, delicate ecology and involving an array of governmental entities to

Figure IV–5—Geographic Limits of Chesapeake Bay Model for Hydraulic and Ecological Studies



manage the Zone. This severe administrative fragmentation, as well as the confrontation between different interests, suggests the need for unifying concepts by which we can deal with these problems.

Much can be accomplished in promoting optimal use of the Coastal Zone by increased emphasis on existing capabilities and on the use of existing authorities. However, it is apparent that a more comprehensive approach to planning and management is now imperative; no longer can there be delay if we are to reverse the degradation of our limited shoreline and realize the full benefit of being a coastal nation. Thus, the member agencies of the Marine Sciences Council are taking steps to encourage the States to strengthen and expand the necessary institutional framework for carrying out planned use of the Coastal Zone in the national interest.

"Navies are not all for war." —MATTHEW FONTAINE MAURY

Chapter V

STRENGTHENING MILITARY PROGRAMS FOR NATIONAL SECURITY

The marine science programs carried out by the Department of Defense, and particularly by the Department of the Navy, are principally designed to maintain and improve the capabilities of our military forces to conduct their assigned missions relating to national security. In view of growing world-wide interest in the oceans, both as potential areas of sophisticated military operations and as a source of living and mineral resources, the importance of military marine science and technology programs is steadily increasing. These programs contribute to more than immediate military purposes. They substantially strengthen our world-wide maritime presence and augment national political, economic, and scientific capabilities.

Our naval forces play a central role in linking us with our allies, deterring potential adversaries, and containing limited conflicts. Military marine science programs are thus directed toward enhancing U.S. capabilities for strategic deterrence; anti-submarine operations; support of amphibious operations, mine warfare, and limited ground action; surveillance of the oceans; and operations to maintain and protect essential shipping.

All military marine science programs are designed primarily to provide ocean-related scientific knowledge and engineering technology upon which to base policies, programs, and developmental and operational decisions related to military security. Military efforts which make substantial contributions to other national needs and goals and which must be described

with them to give a coherent picture of applicable Federal efforts are set forth as an integral part of other chapters of this Report.

Knowledge gained from military programs is, to the extent permitted by security considerations, made available in unclassified form for general use. For example, the Navy's program in mapping, charting, and geodesy produces data and charts for navigation and world-wide shipping activity. During the past year all bathymetric data which would not compromise classified ship operations or installations were declassified and made available for public use. These data include sounding journals, echograms, collection sheets, small scale charts prepared for inclusion in scientific or technical papers, and similar information derived from both conventional and highly precise navigational positioning.

The Navy's programs of ship design and materials development, the most comprehensive in the Nation, provide knowledge for private shipbuilding and Federal maritime agencies such as the Coast Guard, the Environmental Science Services Administration, and the Maritime Administration. Navy developments in navigation, which range from submerged, acoustic, position-keeping devices to systems for locating ship positions precisely on the earth's surface by means of satellites, have been released for scientific and commercial use. The programs of the Advanced Research Projects Agency, directed toward detection of underwater nuclear explosions, provide knowledge of the earth's crust and energy transmission characteristics relevant to earthquake studies and volcanology.

At the same time a number of programs of civilian agencies contribute to Navy capabilities. For example, ESSA's conventional nautical charts and ESSA and Coast Guard surveys assist in meeting Navy requirements.

The Scope of the Naval Oceanographic Program

The Naval Oceanographic Program is concentrated in three areas: ocean science, ocean engineering and development, and oceanographic operations. These programs are intended to enhance the effectiveness of naval operations through a better understanding of the world's oceans and their boundaries and by providing effective materials, equipment, and techniques.

The Ocean Science Program includes the study of the physical, chemical, biological, and geological characteristics of the oceans. Underwater acoustics is a major area of concern. Research and exploratory development in these areas are conducted under the Chief of Naval Research, in his capacity as the Assistant Oceanographer of the Navy for Ocean Science, utilizing the

numerous Navy laboratories and contracts with private institutions, universities, and other contractors, and cooperating with other Government agencies such as the Bureau of Commercial Fisheries.

The Ocean Engineering and Development Program is headed by the Chief of Naval Development in his capacity as Assistant Oceanographer of the Navy for Ocean Engineering with responsibility for undersea search, rescue, salvage, and construction. Inherent in this program is the necessary development effort required to insure that the best materials, tools, vehicles, habitats, and equipment are available for use in the marine environment. These programs are carried out in in-house laboratories and by contract to institutions and to the industrial community. Much of this entire program directly supports the efforts of the Supervisor of Salvage, who fulfills the Navy's broad responsibilities for both military and commercial salvage.

The Oceanographic Operations Program involves direct support of both naval operating forces and navigators generally through the collection of environmental data by specially equipped ships, submarines, aircraft, and buoys, as well as other devices. The transformation of these data into useful products for Navy use, for other national programs, and, in some cases, for international distribution, is a responsibility of the Oceanographer of the Navy. The public obtains scientific and technical information procured, processed, and disseminated by the Naval Oceanographic Office through its charts and publications, its library and public information services, its field offices, and the National Oceanographic Data Center.

Outside the Naval Oceanographic Program, the Navy has numerous other marine science responsibilities—for example, exchanges of information with foreign almanac offices; provision of precise time and time interval capabilities of all military departments; and logistic support of Antarctic programs.

The Fiscal Year 1970 Budget

Well over one-half of the Federal marine science program is sponsored by the Navy. Funds proposed for the marine science components of the military programs, categorized in this Report as programs for national security, amount to $143 million for FY 1970, about 27 percent of the total marine science budget.[1] This represents a 12 percent increase over FY 1969,

[1] All Navy programs are required for national security, but those that benefit the National Marine Science Program in other ways as well are categorized in tables of Appendix A and elsewhere in this Report under other headings.

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reflecting primarily increased support of fleet operations and priority developments in military ocean engineering, as follows:

	Millions of dollars
—surveying the properties of the ocean and ocean bottom (Navy)	$28.3
—marine science and technology in support of weapon systems (Navy)	35.3
—development of undersea search, rescue, recovery, and man-in-the-sea capability—Deep Submergence Systems Project and closely related efforts (Navy)	77.4
—test and calibration facility for instrumentation (Navy)	1.8
—marine science in support of safeguards for limited test ban treaties—VELA program (Advanced Research Projects Agency)	.2

These data of course do not include much of the Navy's applied research and development effort, totalling $2.1 billion in FY 1969, the bulk of which is directed toward development of components for specific weapons systems and construction of prototype equipment.

Ocean Surveys for Defense Systems

The purpose of these surveys is to obtain comprehensive oceanographic, hydrographic, and acoustical information about ocean areas of the world in which our naval forces operate. The surveys provide environmental data both to support current fleet operations and to design future systems. Ocean-wide surveys, including mapping and charting programs described in Chapter XII, acquired vast quantities of precise environmental data over millions of square miles of the North Atlantic and North Pacific Oceans and the Mediterranean Sea in FY 1968. Over one-half million track-miles of controlled sounding lines, 300,000 track-miles of gravity data, 150,000 track-miles of seismic sub-bottom profiles, and 260,000 miles of geomagnetic data were completed. An additional 210,000 miles of airborne geomagnetic measurements were obtained by the Navy's Project Magnet aircraft.

Fifteen Navy surface ships and four airplanes are assigned full time to the collection of oceanographic, hydrographic, and other related geophysical and meteorological data. This large oceanographic fleet is being modernized by the replacement of converted, obsolescent ships with new ones specifically designed and instrumented for oceanographic work. In addition to the full-time fleet, other ships are under contract to the Navy for special oceanographic projects. Still other ships of the Navy and the Coast Guard are used on an opportunity basis to obtain oceanographic information.

Among surveys to be carried out during the next year are: anti-submarine warfare and undersea warfare surveys in the North Pacific, Gulf of Mexico, and North Atlantic; mine warfare surveys in the western Pacific and Mediterranean; and aircraft ice surveys in the Arctic. *Wilkes*—a highly automated oceanographic ship—and four new hydrographic survey ships are scheduled for delivery this year. The increase in the FY 1970 budget request reflects increased ship operating costs, items needed to equip new survey ships and upgrade ship equipment, increased efforts in processing geophysical survey data, and broadened activities to meet increasing fleet requirements.

Marine Science and Technology in Support of Defense Systems

Marine science and technology activities in support of specific weapon systems are directed primarily toward exploratory and advanced development in underwater sound propagation to support sonar design and surveillance systems. The primary objective is to advance the Navy capability to seek, detect, identify, and destroy hostile submarine forces, but the knowledge gained aids in concealing U.S. submarines and thus contributes to preserving the invulnerability of the Fleet Ballistic Missile System. Twenty-six projects at 18 Federal and non-Federal laboratories, including 10 private corporations, are coordinated within a comprehensive program of investigations, of which major elements are:

—acoustical propagation studies of ocean velocity structure, surface and bottom interactions, absorption, and scattering;

—research related to submarine detection and classification, ocean surveillance, target tracking, weapon homing, and submerged communications using a floating instrument platform;

—acquisition of data on sea floor properties and structure, acoustical reflectivity, geomagnetics, and gravity related to anti-submarine warfare system performance;

—field experiments on the spatial and time coherence of sound signals;

—bottom-reflective active sonar and shallow and deep water acoustic propagation studies in selected areas of the Atlantic;

—Pacific Ocean investigations of ambient noise, biological scattering, and other characteristics;

—studies of the variability of ocean currents and temperature structure with moored instruments and remote sensors to develop mathematical prediction models for ocean currents;

—research on the physical and chemical microstructure of the sea relating to sonar and weapon accuracies; and

—studies of biologically produced underwater sound—involving more than 200 fish species—with consideration of geographical, vertical, diurnal, and seasonal distributions as well as ecological and behavioral patterns.

Undersea Search, Rescue, Recovery, and Man-in-the-Sea

This program of advanced ocean technology is intended to improve the Navy's deep ocean operational capability for rescue, search, salvage, exploration, and diving operations. The need for such a capability was again emphasized in 1968 by the loss of the *Scorpion* and of a French and an Israeli submarine.

The *Deep Submergence Systems Project* (*DSSP*) has specific mission requirements for:

—submarine location, escape, and rescue;
—object location and small object recovery;
—large object salvage;
—Man-in-the-Sea; and
—the nuclear powered, research and engineering submersible (NR–1).

Application of deep submergence and ocean engineering technologies also now appears feasible in the areas of mine warfare, amphibious operations, undersea command and control systems, advanced undersea strategic weaponry, and underwater surveillance and reconnaissance.

The *Submarine Location, Escape, and Rescue Program* will develop the capability to:

—locate a distressed submarine and retrieve data to assist investigators in determining the cause and nature of the disablement;
—provide personnel escape techniques from 600 feet; and
—provide an all-weather rescue system operational to submarine collapse depths using Deep Submergence Rescue Vehicles (DSRV's—small submarines which can either be transported by air or carried submerged on the deck of a "mother" submarine).

Completion of the development, design, and construction of two DSRV's is anticipated in FY 1970 together with construction of launch and repair facilities at San Clemente Island. The first two DSRV's are scheduled to become operational in 1970. These vehicles will be battery-powered, have a crew of three, transport 24 rescuees, and have an operating depth capability of at least 3,000 feet.

The *Small Object Location and Recovery Project* aims at a capability to locate and recover small objects at great depths in relation to the Navy's

salvage mission. For this purpose, Deep Submergence Search Vehicles (DSSV's) are being designed capable of operating at a depth of 20,000 feet for about 30 hours and lifting objects which weigh 250 lbs.

The *Large Object Salvage System Project* is intended to provide a system capable of recovering large objects, including intact submarine hulls, from depths down to 850 feet. Efforts have thus far been limited to feasibility studies, development of lift hardware, and coordination with SEALAB experiments. An advanced development effort will not be funded in FY 1970, but exploratory development will continue.

The *Man-in-the-Sea Project* is directed toward developing new equipment to permit man to live and work underwater. Both private industry and the Navy are developing the equipment and techniques by which divers can work in the sea longer, at greater depths, with better tools and increased safety. The goals of accomplishing useful work by increasing diver capabilities, communications, and visibility at 600 feet—then 850 feet and eventually at least 1,000 feet—were brought nearer by such developments as:

—SEALAB III, utilizing saturated-diving techniques, will begin early in 1969 at a depth of 600 feet, off San Clemente Island (Figure V–1);

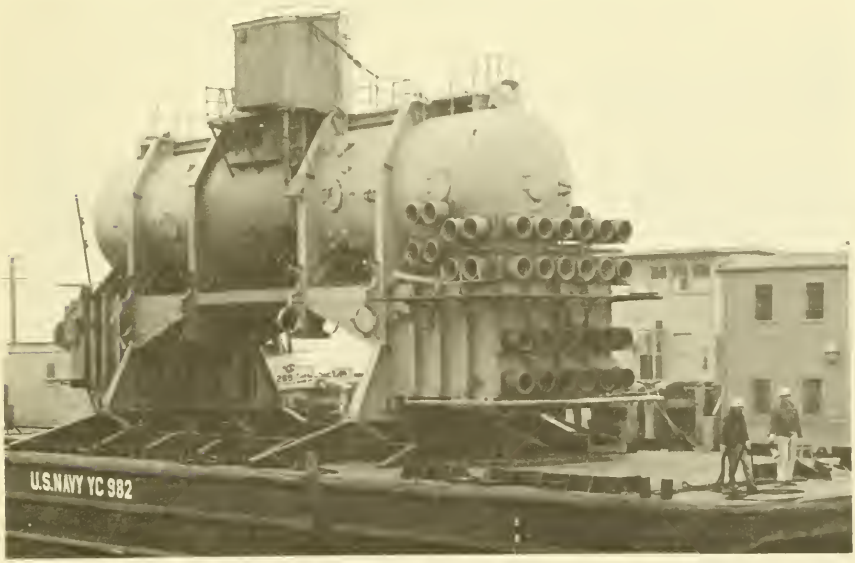


Figure V–1—*The SEALAB III habitat is shown in its final stages of fabrication, with the spools which will hold the life support umbilical cables extending to the right. SEALAB III experiments, scheduled to begin off San Clemente Island, California, in early 1969, will extend man's capability to work underwater to a depth of 600 feet.*

—initial use of the prototype Navy Mark I and Mark II Deep Dive System, designed for 1000 feet;
—fabrication of an experimental model communication system that has shown superior intelligibility to the 600 feet depth with the microphone and electronics contained in the facemask; and
—completion of studies suggesting that (a) in the United States saturated diving may account for 50 percent of all military diving in 1980, (b) divers will have adequate natural visual perception only 5 percent of the time, (c) self-contained communication equipment capable of 90 percent intelligibility within a range of 2,000 yards at a depth of 1,500 feet is capable of meeting most diver portable communications requirements, and (d) compact underwater heaters are required to protect divers from environmental cooling.

The Navy is constructing a nuclear powered research and ocean engineering submersible (NR–1) which combines the long endurance of a nuclear power plant with the control and instrumentation developed for the DSRV rescue submersible. Carrying a crew of five plus two observers, the NR–1 will also provide the technical basis for future development of nuclear-powered, oceanographic research and survey submersibles to operate at even greater range and depth. Current scheduling calls for sea trials and operations in early 1969.

Biomedical Research and Development

Advanced biomedical activities of the Navy Bureau of Medicine and Surgery are developing criteria for life support, health maintenance, and environmental control at 1,000 feet underwater equivalent pressure. A joint Navy-Duke University saturation dive to a simulated depth of 1,000 feet was completed in December 1968. During the 77 hours and 30 minutes spent at saturation depth, the divers performed extensive physical and medical tasks in a normal manner. All observations indicated that divers can perform well under these conditions if life support systems maintain a level of support equivalent to that at the surface. The detailed medical results of the dive, to be published in the near future, will make available comprehensive information in such areas as heart rate, respiration frequency, oxygen consumption, carbon dioxide elimination, partial pressure in arterial blood of oxygen and carbon dioxide, central nervous system function under various conditions, and human performance and reaction response at deep depth.

Priority in FY 1970 will be given to (a) calculation and evaluation of several sets of decompression schedules for use in four different fleet systems,

(b) physiological studies in deep chamber dives, (c) helium speech translation techniques, (d) acquisition and installation of research equipment at both in-house and civilian laboratories, and (e) preparation of a long-range development plan.

Activities of the Advanced Research Projects Agency

To improve our ability to detect, locate, and identify underground and underwater nuclear explosions, the Advanced Research Projects Agency (ARPA) has for a number of years conducted a project called VELA. Some of ARPA's significant marine science efforts during the past year included:

—a seismic calibration experiment off Amchitka Island involving detonation of a 250-ton slurry charge at a depth of 3,000 feet;

—experiments to evaluate the influence of turbulent diffusion and currents of large subsurface bodies of contaminated water by tagging subsurface, open-ocean waters with fluorescent dye and following the resulting pool for five days;

—design, fabrication, and testing of equipment for detonation of 10- to 1,000-ton underwater chemical explosions; and

—collection and analysis of sea water samples to determine background levels of radionuclides in selected areas of the Arctic Ocean.

Research and development on detecting, locating, and identifying nuclear explosions in the ocean has been successful, and this part of the project VELA is now being phased out with virtually all work directly concerned with ocean properties to be completed in FY 1969. Other parts of the VELA project are continuing, including seismic calibration experiments in the oceans intended to provide information on the earth's crust and upper mantle.

ARPA will be engaged in advanced marine science and technology as part of the Agency's mission to demonstrate the feasibility of emerging technologies for possible military application. ARPA is particularly interested in technologies which could drastically change our defense posture in such critical areas as anti-submarine warfare (ASW), forward basing, and control and use of the sea surface. ARPA will be working closely with the Navy, although projects of interest tend to have a multiservice applicability. Two $8 million projects are under serious consideration at this time:

—demonstration of the feasibility of a cost effective, large, ultra-stable floating platform with potential for advance support; and

—demonstration of the feasibility of very high speed surface effect vehicles with potential for ASW and convoy protection, and for operations over shallow water, in certain coastal areas, and over ice.

The use of very high speed surface effect vehicles with floating platforms and compatible sensors and weaponry might provide new solutions to several critical defense problems.

Our Nation's goal is lasting peace, and we seek it by every means, including a strong Navy. We have no monopoly, however, on naval forces or technology. Our present advantage in nuclear propulsion and underwater technology is a key to maintaining superiority in naval strength, by quality as much as by numbers. The roots of naval technology must be continuously reexamined, existing systems refined, and new concepts developed in order to maintain our sea-based defense forces essential for national security.

"There are as good fish in the sea as ever came out of it."
—ENGLISH PROVERB

Chapter VI

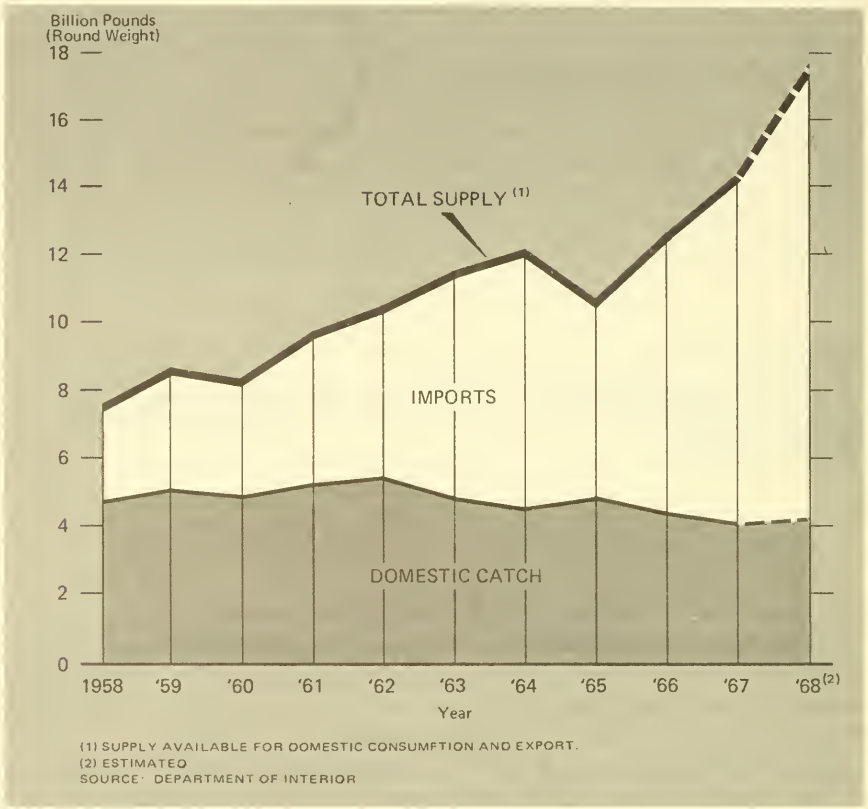
ACCELERATING USE OF FOOD FROM THE SEA

A strengthened fishing industry can contribute to economic development at home and abroad, improve our balance of trade, broaden our research and industrial base to explore and use the oceans more effectively, enhance our stature as a world maritime power, and provide new tools in combatting hunger and malnutrition in the developing areas of the world.

The United States has become the world's most lucrative market for fishery products with a two-fold increase in demand during the past ten years. However, while the fishery catch worldwide and off our coast has more than tripled during the past two decades, the total catch by U.S. fishermen has slightly declined, with the United States now sixth among the world's fishing nations. This problem in U.S. fisheries is further aggravated by the fact that foreign fishermen take most of the catch from the many highly productive high seas fishing grounds off the U.S. coast, and about three-fourths of our domestic demand is satisfied by imports (Figure VI–1).

The demand for fishery products at home and abroad will continue to grow, and fishing activities along our coast will probably continue to intensify in view of the abundance of known nearby resources which are not now being exploited. Thus, expansion and further improvements in the vitality of our fishing industry—and particularly a revitalization of large segments of the harvesting sector of the industry—could contribute to our economy, provide a wider variety of high quality, low cost, fishery products, and reduce balance of payments deficits through improved com-

Figure VI–1—U.S. Supply of Fishery Products



petitiveness of U.S. industry. Also, many of our small coastal communities are almost totally dependent on a healthy fishing industry. For example, in Alaska 30 percent of the civilian labor force is engaged in fishing which accounted for 54.5 percent of the processed value of total natural resource production of the State in 1966.

As world food producers struggle to keep pace with a rapidly expanding population—and statistics indicate that this disparity is actually increasing rather than decreasing—accelerated development of food from the sea offers high promise of meeting a part of the growing worldwide need for animal protein—an unmet need of a billion people currently suffering from malnutrition. Indeed, in recent years fish consumption has grown worldwide more rapidly than population. Innovative applications of contemporary science and technology can turn currently underutilized fishing stocks into new food sources for developing areas. The United States is thus motivated

to advance programs which will reduce threats to world order born in areas of malnutrition, extend our humanitarian traditions, and strengthen the economies of developing nations which are striving to become self-sustaining contributors to the world economy.

The Marine Sciences Act states that the U.S. marine science program should contribute to rehabilitation of our commercial fisheries, to accelerated development of marine resources, and to international cooperation in the national interest.

Developing food from the sea for the War on Hunger was one of the first initiatives adopted by the President in relation to the Marine Sciences Act. Steps were taken to strengthen further a long-range program to exploit the oceans more fully as a source of food to help feed the undernourished people of the world through U.S. technology and leadership.

State of the U.S. Fishing Industry

During the past two decades there has been a growing dichotomy between the processing and distribution segment of the fish food industry, which has grown both domestically and abroad, and the harvesting segment, large parts of which have remained static. U.S. processing and distribution firms have established extensive collecting networks for raw and semi-processed fishery products in more than 30 countries, primarily in the developing world. This has been accomplished through such instruments as wholly owned fishing and processing firms in those countries, loan of risk capital for vessel or plant construction to local entrepreneurs, technical assistance for technical advances and quality control, and guarantee of U.S. markets to local enterprises.[1] At the same time U.S. food processing companies have made relatively low capital investments in U.S. flag fishing vessels. This increasing dependence on foreign sources of primary production has contributed to locally depressed incomes and unusually high unemployment in some localities where U.S. fishermen are centered.

A number of domestic fisheries are making good catches with high economic returns. But many others are static—with excess catching capacity,[2]

[1] The Council contract report "Multinational Investment Opportunities in Ocean Activities" describes some of these activities.

[2] In several fisheries, the catching capacity of the fleet is far greater than necessary to take the sustainable yield for the resource. For example, according to recent studies, the present annual catch of Georges Bank haddock could be taken with 30 percent fewer vessels than now used. This would mean that total revenues would remain the same but that total costs would diminish considerably. Each vessel, now operating at an average annual loss of $8,000 per year, could instead be earning a profit of $30,000, and annual income per fishermen would increase from $6,600 to over $10,000.

obsolescent equipment, low income, and low returns on investment. The average age of the U.S. fishing vessel in 1966 was 20.3 years. Only four new vessels have been added to the Boston offshore trawler fleet in the past 16 years, and the average Pacific coast halibut vessel was built 36 years ago. The vessel costs to Canadian fishermen competing for stocks off U.S. coasts are often one-half the comparable costs to our fishermen.

Many interrelated factors contribute to these problems, including:

—a tangle of Federal, State, and local laws and regulations, which were originally designed to conserve species, reduce conflicts among multiple users of the coastal waters or among groups of commercial fishermen, or to protect certain limited interests, but which have increased costs and inhibited efficiency of fishing by retarding application of contemporary technology and limiting fishing areas;[3]

—more fishermen participating in some fisheries than necessary to make the maximum sustainable annual catches, with the result that the share of each participant is reduced;

—fragmentation within the harvesting segment of the industry into entrepreneurial units too small to finance technological improvements and to minimize the impact of the vagaries of supply and demand;

—high cost of building vessels in U.S. shipyards[4] and high insurance rates resulting in large measure from the liberal interpretation of the laws concerning vessel owner liability for crew injuries;

—separation of harvesting and marketing interests, with the fisherman often unable to influence the market significantly and stimulate demand for many readily available species, thus relieving increasing pressures on those limited stocks where a growing demand is causing a decreasing yield per unit of fishing effort;

—inadequate knowledge of fish stock distribution, abundance, behavior, and fishing conditions and related limitations on the number of species being caught, the areas being fished, and the fishing methods being used; and

—high vessel casualty rates, resulting in loss of life and property and high insurance rates.[5]

One major effect of all these forces working against improved efficiency in the harvesting of fish has been a reduction in the average output per U.S.

[3] These laws and regulations are summarized in the Council contract report "The Land-Sea Interface of the Coastal Zone of the U.S."

[4] A 1793 law (46 USC 251) in effect requires that vessels over five net tons engaged in our fisheries must be built in U.S. shipyards. A 1966 subsidy law, intended to offset the high costs of construction in the United States, has not had a significant impact and at the same time reduces incentives to lower construction costs.

[5] *A Study of Cost Benefits and Effectiveness of the Merchant Marine,* U.S. Coast Guard, May 1, 1968, identified fishing vessels as having the poorest safety record of any group of U.S. vessels.

fisherman which, since 1964, has fallen below the 1957–59 average. Conversely, for the U.S. economy in general, the average output per worker increased over 30 percent from 1957 to 1967 and, in agriculture—an industry whose products compete with fish in the food market—there has been a 67 percent increase. These trends are similarly reflected in the comparative wages for fishermen and for workers in other industries.

A New Emphasis To Revitalize Our Fishing Industry

During the past several years numerous studies have been conducted within and outside the government to identify more clearly ways to overcome impediments to growth of the harvesting sector of the seafood industry. Of particular importance was a March 1968 conference of representatives of all parts of industry, partially supported by the Council.[6] The conference underscored the need for the Federal Government to reexamine fishing restrictions that reduce efficiency of the fisherman, consider limiting the number of fishermen exploiting stocks already being fully harvested, improve statistics on fisheries, strengthen U.S. policies concerning fishery management, and take into account food shortages on a world-wide scale in promoting development of the domestic industry. Private industry was urged to develop and expand the seafood market and to provide better education and training in the industry.

In recognition of the many benefits to be realized from a strengthened fishing industry, the Marine Sciences Council this year endorsed the following approach for expanding the catch by U.S. fishermen and for developing a healthy industry:

1. Steps should be taken to:
   —provide uniform Federal guidelines for fishery conservation and management that would eliminate unnecessary restrictions and inconsistencies and foster selective revisions of State and local laws;
   —encourage the development of competitive ships and equipment in the United States by revising the fishing vessel subsidy program; and
   —encourage increased opportunities for the sale of the catch of U.S. fishermen and for vertical integration of the U.S. industry.
2. The Bureau of Commercial Fisheries should give increased attention to:

[6] The Conference on the Future of the U.S. Fishing Industry was held on March 25–27, 1968, at the University of Washington in Seattle. Sponsored by the University and industry as well as the Federal Government, it brought together 266 experts from the diverse segments of the fishing and fish processing industry.

—estuarine ecology, aquaculture,[7] the technology of extracting concentrated fish proteins, expanded knowledge of fish populations on the Continental Shelf, and development of fish locating and catching equipment and methodology;

—an improved Federal program of statistics, data processing, and information dissemination to the fisherman through extension programs; and

—assistance to industry to produce clean, safe, and wholesome fishing products with a level of graded products comparable to those in meats and poultry.

During FY 1970 the Bureau of Commercial Fisheries plans to study Federal, State, and local laws that restrict use of efficient gear and foster economically irrational conservation measures and to develop recommendations as to desirable modification of these laws that will permit adoption of technological innovations that lead to higher economic yields. Additionally, BCF has reorganized its technical support of local fishery programs by making available a central pool of expertise to respond to a wide variety of problems.

Successful implementation of cooperative programs of government, industry, and the scientific community could significantly increase the proportion of fishery products supplied to the U.S. market by the domestic fleet—benefiting both the consumer and the fisherman as well as the general economy. Also, our position to negotiate international agreements could be greatly strengthened through an increased U.S. presence in fishing grounds.

Fishery development and seafood technology programs include:

1. *Resource development and management programs*, accounting for 62 percent of the FY 1970 BCF marine science budget of $44.5 million. In 1968, BCF:

—conducted studies of the influence of reef habitats on lobster behavior off New England which may lead to a significant increase in lobster abundance;

—developed transplantation methods that nearly eliminate "winter kill" of oysters in Long Island Sound;

—artificially hatched and reared to postlarval stages the four common commercial shrimp species of the Gulf of Mexico;

—continued participation in the international cooperative oceanographic and fishery investigations of the eastern tropical Pacific, including discovery of unexpectedly high nutrient concentrations in upper ocean layers south of the Equator;

[7] The Council contract report "The Status and Potential of Aquaculture" surveys world-wide aquaculture activities and concludes that "farming the sea" can make a significant contribution to the domestic economy as well as to the War on Hunger.

—conducted the world's largest fish tagging program to delineate Atlantic menhaden migrations and provide a basis for estimating natural and fishing mortality;
—improved assessment of salmon distribution in the northeastern Pacific and the effect of industrially induced thermal variations on survival of salmonid and other species in the Columbia River; and
—improved fishery forecasting services in the eastern Pacific.

2. *Processing and marketing programs,* accounting for 13 percent of the FY 1970 budget. In 1968, BCF:
—inaugurated a program of seafood merchandising workshops;
—developed an insulated leakproof container for transporting fresh fish; and
—improved techniques for mechanical peeling of northern shrimp.

3. *Advanced technology programs,* accounting for 8 percent of the FY 1970 budget. In 1968, BCF:
—developed modifications to trawl gear for New England groundfish which demonstrated a significant increase in catch;
—developed a new wing trawl to reduce unwanted fish and debris from catches by the Pacific northwest shrimp industry;
—delineated the calico scallop resource off the east coast of Florida which is expected to create a major new fishery;
—tested sonar and aerial photographic techniques for detecting and assessing pelagic fish schools in the Gulf of Mexico;
—increased significantly the catches of alewives and chubs in Lake Michigan through use of an electrified trawl system and developed and tested surface nets for removal of dead alewives; and
—developed pond catfish harvesting equipment.

4. *Economic research programs,* accounting for 2 percent of the FY 1970 budget. In 1968, BCF
—analyzed the impact of imports on the New England groundfish industry and the U.S. fishmeal industry;
—assisted in initiation of an anti-dumping study of imports which compete closely with New England fishery products; and
—initiated systems analysis for the New England haddock fishery based on previous systems analysis sponsored by the Marine Sciences Council.[8]

5. *International activities.*—Details of some of the most significant international fishing programs for which the Bureau has provided the scientific data and technical personnel are described in Chapter III. This type of activity accounts for about 1 percent of the FY 1970 budget.

In addition to these marine science programs, the Bureau of Commercial Fisheries is also responsible for three financial assistance programs which

[8] "A Systems Analysis of Specified Trawler Operations."

are intended to offset, in part, the high costs of ship construction and operation to American fishermen compared with the costs to some foreign competitors. These programs consist of loans for fishing vessels and gear, fishing vessel mortgage and loan insurance, and fishing vessel construction differential subsidies. Two large stern ramp trawlers, each capable of processing two million pounds of fishery products during a 60 to 90 day trip, were completed under the subsidy program. They are the first vessels of this type in the U.S. fishing fleet; one will operate off the Atlantic Coast and the other off the Pacific Coast. The Bureau also administers three grant-in-aid programs to the States for research and development as a basis for more effective management of commercial fishery resources.

The Atomic Energy Commission supports a broad range of advanced investigations related to the presence of radionuclides in the oceans, their interactions with organisms, and the use of tracers in oceanic research. Other research has demonstrated that the ice-storage shelf-life of haddock, cod, sole, and shrimp can be extended from 7 to 14 days by irradiation.

The Food and Drug Administration has assumed responsibility for the Shellfish Sanitation Program, a Federal-State-industry program designed to insure safety of shellfish shipped in interstate commerce through surveillance of water quality, evaluation of sanitation facilities of packers and shippers, and review of State control programs. FDA research programs include the nutritional and health aspects of marine foods, marine bacterial toxins and pharmaceuticals, and use of marine life in biomedical research. Related research of the HEW's Environmental Control Administration includes studies of the course of viral pollutants in estuaries, their accumulation by shellfish, and the effectiveness of purification processes in removing these viruses from shellfish.

The Smithsonian Institution provides essential back-up information on the kinds of fishery organisms being sampled, produces monographs and guides to the identity of harvested organisms and those serving as food for commercial species, provides information on the populations and distributions of species which might have commercial importance or which are parasites and predators on useful species, and provides a sorting service for bulk samples of marine species.

The Coast Guard participates in enforcement of international fishery arrangements.

Using Food from the Sea in the War on Hunger

In recognition that food from the sea offers considerable promise in meeting a portion of the world's protein deficiency, the United States embarked in 1967 on a new Food-from-the-Sea Program with the Agency

for International Development assuming lead agency responsibility for the program. Initial objectives included development of competitive commercial processes for producing FPC.[9]

The program is intended to:

—determine and develop the potential market for FPC in selected developing countries;

—establish a viable commercial FPC system in at least one protein-deficient country; and

—encourage other nations and private interests to establish commercial fishing industries in the developing countries.

AID has conducted preliminary surveys of the opportunities for developing FPC capabilities in a number of Latin American, Asian, and African nations. As a result of these surveys, more intensive studies have been initiated on a bilateral basis in Chile, Korea, and Morocco to determine whether and in what form FPC-fortified foods can be marketed commercially in these countries. These studies will continue through FY 1970 and will assist potential investors in determining the commercial attractiveness of FPC investments. They encompass:

—*market analysis* including identification of factors contributing to dietary patterns and determination of opportunities for encouraging consumer acceptability of FPC such as introducing FPC into government feeding programs;

—*supply analysis* to determine availability of an adequate supply of inexpensive underutilized fish stocks; and

—*product development and testing* to determine the suitability of FPC in fortifying local foods such as flour, bread, and pasta.

During 1968, AID ordered $900,000 worth of FPC from Alpine Marine Products Corporation for use in overseas feeding programs conducted by voluntary agencies. The contract price was 42 cents per pound. This FPC will be used as an additive in a number of basic foods, complementing the product development and testing programs in Chile, Korea, and Morocco. A second purchase is proposed in FY 1970.

[9] Many abundant fish species can be converted into a nutritious and wholesome protein concentrate (FPC) that is tasteless and odorless. The FDA has authorized two processes for producing FPC from hake or hake-like species. FPC is bacteriologically and biochemically safe and stable without refrigeration or other special process. Its protein is easily digestible. It can be easily stored and transported and can be readily added to a variety of foods commercially consumed in the developing nations. Ten grams will provide adequate animal protein to meet the daily requirements of one child. Research is underway to reduce the cost of this daily requirement to less than one cent per day which is expected to make FPC competitive with other protein supplements.

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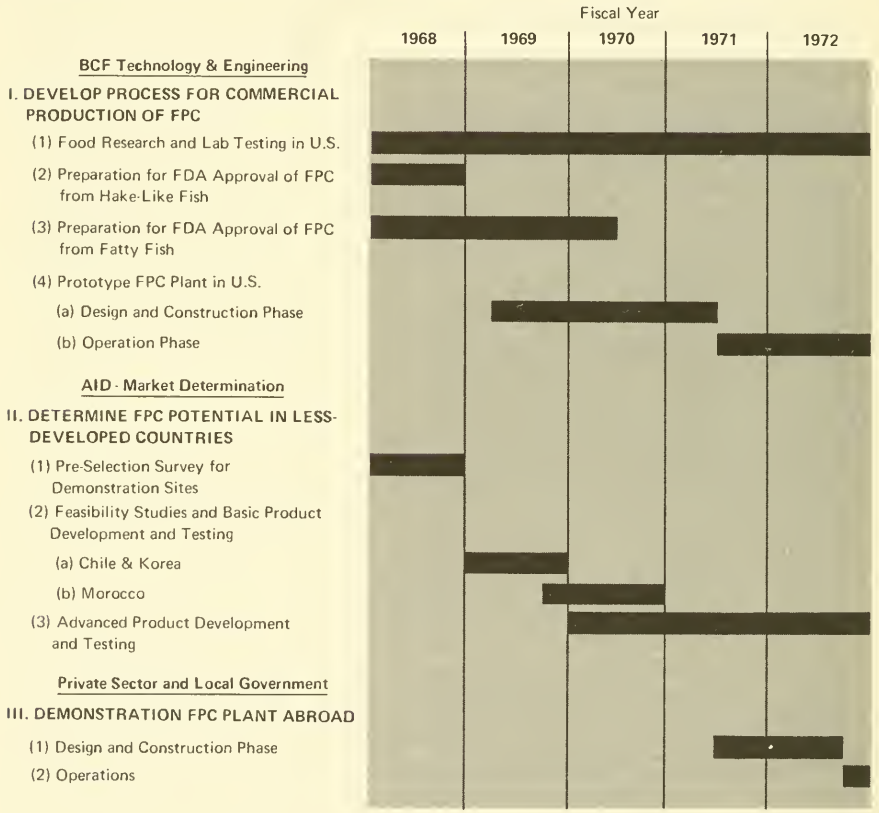
Figure VI–2 presents the current status and planning for implementing the program.

Figure VI–2—Phasing Chart for Food-from-the-Sea Demonstration Program



Developing FPC Technology

During 1968 the following accomplishments highlighted the FPC development program:

—establishment of a special FPC office in BCF;

—completion of process development for extraction of FPC from lean fish at laboratory scale and preparation of provisional specifications and engineering data for the full-scale demonstration plant;

—award of a contract, as authorized by P.L. 90–549, for design, construction, and operation of a 50-ton per day FPC demonstration plant at Aberdeen, Washington, which is intended to demonstrate

feasibility of large-scale FPC processes at reasonable costs and to provide engineering and economic data to assist private industry in construction of commercial plants;
—continuation of studies on safety aspects of processing lean fish;
—conduct of solvent extraction studies in-house and by M.I.T. and Standard Oil of New Jersey which will provide design parameters for an efficient recovery system;
—initiation of laboratory work on extracting FPC from fatty fish; and
—extension of research concerning extraction of FPC by biological processes leading to more versatile and cheaper products.

In view of the continued promise of FPC as an inexpensive source of protein, the Bureau of Commercial Fisheries will continue FPC research and development at a level of $2.2 million in FY 1970. These efforts will include completion of a prototype process for fatty fish so that industry can have sound engineering designs as well as control and operating data. Work to examine and develop new, lower cost biological and other processes for producing FPC from various fish species will be emphasized.

The FPC development program is intended to provide the knowledge for sound and systematic transition from laboratory experiments to an economical and acceptable food production system from fish catching through consumption. It should provide the basis for the development of commercially viable operations in this country as well as overseas. The food-from-the-sea budgets of AID and BCF are presented in Table VI–1.

Looking to the Future

The importance of a healthy fishing industry and of a vigorous Food-from-the-Sea Program has been widely recognized by government, commercial, and industrial interests. Delay in taking steps to revitalize the industry will lead to further gains by other nations in exploiting resources off our coasts, lost opportunities to turn latent resources into foods, and potential erosion of our position as a maritime nation. Bold and imaginative measures are needed to reverse this trend.

Similarly, the problem of hunger has become so serious that innovative approaches are essential. Consideration might be given to such steps as inexpensive, small-scale automated units for processing FPC suitable for operation in isolated coastal regions of developing countries. Optimum utilization of fishery resources also requires development of integrated systems for areas where fishing capabilities are limited and fishing conditions are favorable. Among the possibilities are factory ships operating with satellite catching fleets supplying very large regional processing plants and

Table VI–1—Food from the Sea in the War on Hunger

(Obligations in thousands of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
Bureau of Commercial Fisheries (BCF):			
Research and development	1, 209	2, 197	2, 197
Demonstration plant	0	325	675
BCF subtotal	1, 209	2, 522	2, 872
Agency for International Development (AID):			
FPC purchase	900	63	600
Pilot plants	0	0	15
FPC feasibility study	268	180	180
Subtotal FPC	1, 168	243	795
Fishery surveys	0	70	50
Investment surveys	95	100	100
Center of competence	0	0	500
Benefit (nutrition) study	27	0	0
Central research [a]	64	0	126
Direct fish production [b]	0	163	778
General technical assistance [c]	1, 643	1, 952	2, 269
Subtotal, other items	1, 829	2, 285	3, 823
AID subtotal	2, 997	2, 528	4, 618
Total food from sea	4, 206	5, 050	7, 490

[a] Agrarian University and unspecified projects.
[b] New programs in Vietnam and Eastern Asia.
[c] Mostly United Nations Development Program.

development of large aquacultural systems in fresh, brackish, or salt water ponds.

As the initial Food-from-the-Sea Program advances, a capability could be established in a few years to provide protein supplement to 7 to 10 million people. In the longer term, FPC has the potential to meet animal protein needs of over 200 million—using only a small percentage of the projected world fish catch.

"Rich and various gems inlay
The unadorned bosom of the deep."
—JOHN MILTON

Chapter VII

ENCOURAGING DEVELOPMENT OF NON-LIVING RESOURCES

Ores, minerals, and fossil fuels are basic sources of energy, construction materials, metals, chemicals, and fertilizers and are increasingly required by advancing industrial economies. The importance of offshore petroleum and natural gas is reflected in estimates that, within two decades, 30 to 40 percent of the domestic and world production will come from offshore sources. Currently, 15 percent of U.S. production of sulfur comes from offshore, and additional areas have been identified in the Gulf of Mexico. While the potential for offshore solid minerals is still in the exploratory stage, projections show that U.S. consumption of many commodities will double by 1980. This motivates offshore exploration for selected minerals such as gold, silver, platinum, phosphates, and manganese. Additionally, the demand for sand, gravel, shells, and other construction materials dredged from nearshore waters is increasing significantly in areas where rapid urbanization is simultaneously enlarging the need and excluding land sources of supply. Of course, the keys to offshore production of any of these commodities lie in their actual delineation by surveys and in the development of suitable extraction technologies that would render costs of difficult offshore production competitive with conventional onshore operations.

The value of all minerals produced from Federal and State offshore waters in the past decade exceeds $7.5 billion, including petroleum production valued at about $6 billion. Federal bonuses and revenues from de-

velopment of the Outer Continental Shelf (OCS)[1] have steadily grown as shown in Figure VII–1. To illustrate their importance, the $1.7 billion bonus payments received from three *OCS* lease sales over an 11-month

Figure VII–1—Comparative Federal Revenue from Onshore and Outer Continental Shelf Oil, Gas, and Minerals

period in 1967–68 slightly exceed the total revenue received from the sale and production of *onshore* mineral leases since the mineral leasing program began in 1920.[2] Table VII–1 depicts the value of marine mineral production along the U.S. coast.

[1] The Continental Shelf covers approximately 860,000 square miles, one-third of our present land area. The Outer Continental Shelf is that portion of the Shelf beyond 3 miles from the coast, except along the Gulf coasts of Florida and Texas, where it is defined as the area beyond 3 marine leagues.

[2] Appendix H of "Marine Science Affairs—A Year of Plans and Progress" presents detailed statistics on oil and gas extraction on the U.S. Outer Continental Shelf in recent years.

Table VII-1—Value of Mineral Production from Oceans Bordering the United States, 1960-67

(In millions of dollars)

Year	Marine Mineral Production by Source			
	Magnesium metal and compounds, salt and bromine [a]	From wells: petroleum, natural gas, and sulfur [b]	Sand and gravel, zircon, feldspar, cement rock and limestone [c]	Combined
1960	69.0	423.6	46.8	539.4
1961	73.0	496.6	46.2	615.8
1962	89.1	620.7	44.3	754.1
1963	84.6	730.8	42.5	857.9
1964	94.5	820.3	43.6	958.4
1965	102.6	933.3	51.4	1,087.3
1966	117.0	1,177.7	51.6	1,346.3
1967	145.4	1,404.8	55.9	1,606.1
8-year total	775.2	6,607.8	382.3	7,765.3

[a] Sea water.
[b] Ocean subfloors.
[c] Beaches and seafloors.

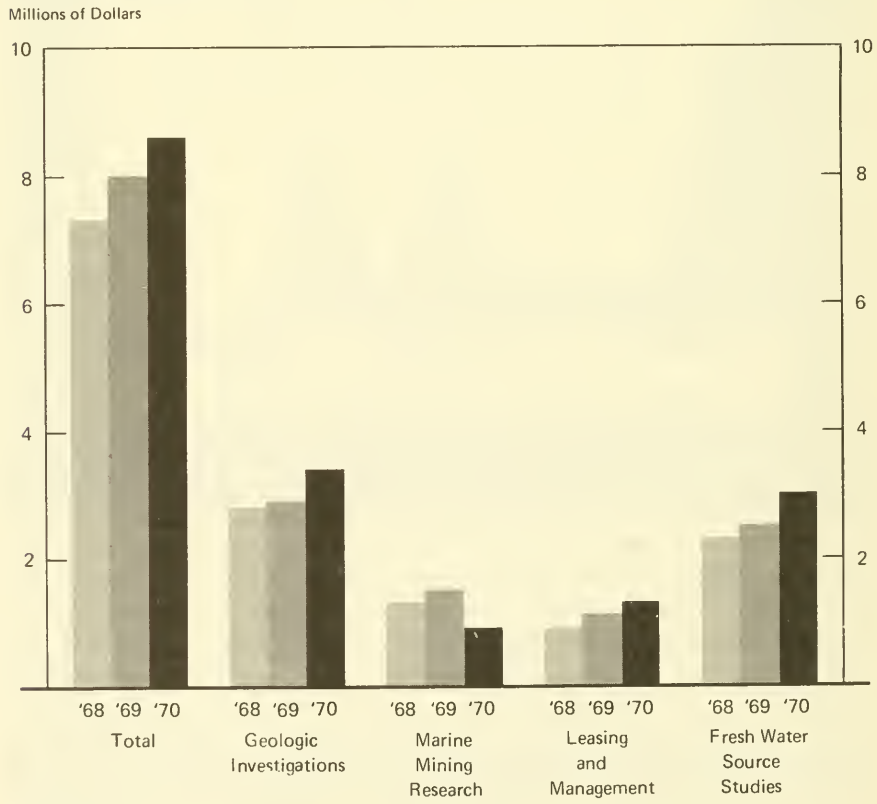
Source: Department of Interior.

Federal Programs To Facilitate Resource Development

Offshore resources can play an increasingly important role in attaining the national objective of insuring an adequate supply for the indefinite future of minerals and fuels, sufficiently low in cost to stimulate economic growth and sufficiently dependable to provide for emergency conditions. A framework of law and public land management is essential to encourage and facilitate private investment and initiative to develop offshore resources. Policy decisions in turn must be based on adequate knowledge of the nature and extent of offshore resources and on a full appreciation of the interaction of resource exploration and exploitation and the many other uses of the marine environment. Thus, Federal marine science programs are designed to expand our general knowledge of the geology and resource potential along our coasts and, in cooperation with industry, to stimulate the development of technologies for delineating potential mineral deposits. Also, Federal services are directed to mapping and charting, weather and ocean predictions, and safety of life and property to facilitate private offshore development.

Federal programs specifically directed at the development of non-living resources from the marine environment include the marine minerals programs of the Geological Survey and the Bureau of Mines, marine water resource studies of the Geological Survey and the Office of Saline Water, and the resource management functions of the Bureau of Land Management with technical assistance from the Geological Survey.[3] As shown in Figure VII–2 these programs amount to $8.6 million requested for FY 1970, compared with $8.0 million appropriated for FY 1969. Programs of other Federal agencies, particularly the mapping programs of ESSA and Navy, also contribute to location and identification of shelf resources.

Figure VII–2—Federal Funding in Marine Science for Development of Non-Living Resources



[3] The Office of Saline Water programs of development and demonstration of desalting methods are not included herein.

1. The *Geological Survey's* marine program is directed to:
   —appraising undeveloped mineral, water, and energy resource potentials of the Continental Shelf and Slope;
   —relating marine geological processes to occurrence of land and ocean floor resources;
   —evaluating hazards to engineering related to seafloor stability;
   —supplying geological data essential to the management of marine mineral resources and wise coastal land use; and
   —contributing fundamental data on the origin of the continental margins and the deep ocean basins.

The Geological Survey currently supports research in-house, at universities, and at oceanographic institutions, through service contracts with industry and by cooperative programs with other Federal agencies. Among the 1968 accomplishments of these programs were:

—*Bering Sea*—discovery of several large sedimentary basins with indications of hydrocarbon accumulations and outlining of target areas where high gold concentrations may occur;
—*Oregon-California*—identification of gold anomalies in nearshore, surface sediments;
—*Northeastern Atlantic Coast*—delineation of large tracts of sand and gravel of significant economic potential; and
—*Puerto Rico*—delineation of offshore canyons which may be suitable for dumping mining wastes without adversely affecting the marine environment.

Additionally, increased emphasis is being given to programs to analyze geological and geophysical data collected by private companies in the course of offshore oil and gas exploration and development. With regard to responsibilities in the field of water resources, a new program in hydrology includes use of mathematical models to describe the movement of solutes in estuaries. Also, the Office of Saline Water conducts research on the chemistry and behavior of saline water systems.

2. The *Bureau of Mines* conducts continuing studies of the U.S. position with respect to consumption, domestic production, and reserves of more than 80 mineral commodities, including examination of the economics of minerals production and acquisition from marine and alternative sources. The marine program of the Bureau is designed to assist in the development of technology for the extraction and beneficiation of marine minerals and the development of equipment and techniques for sampling and delineation of marine mineral deposits.

During the past year, the Bureau of Mines, in cooperation with the Geological Survey, completed a research project off the southern coast of the Seward Peninsula to develop equipment and techniques for obtaining the deposit characteristic and environmental data needed for reliable evaluation of seafloor placer-type mineral deposits and for defining the initial problems in the development of a mining system. Over 500 miles of subbottom profile lines were run; 56 holes were drilled; and over 20 tons of

seafloor sediment were processed in shipboard laboratory facilities. Results indicate that relatively rapid penetration of the shallow ocean floor sediments can be accomplished from surface ships yielding characteristic samples which can be processed and analyzed aboard ship. In operation, a hole could be drilled and complete sample analyses made available within six hours.

Table VII–2 describes current worldwide marine mining activity.

Table VII–2—Recent Marine Mining Activities

Resource	Activity [a]	Depth (feet) [b]	Location
Aragonite	Dredging	150(?)	Bahamas.
Diamonds	Dredging	600—	Southwest Africa.
Gold	Exploration	600—	Philippines.
	Exploration	200—	Alaska.
Heavy metals	Exploration	600—	Australia.
	Exploration	600—	New Zealand.
	Exploration	600—	Tasmania.
Iron	Exploration	600—	Philippines.
Iron sands	Dredging	30—	Japan.
	Exploration	600—	Papua and New Guinea.
Manganese	Exploration	600–2, 400	Blake Plateau.
Manganese nodules	Exploration	12, 000±	Canada (B.C.).
	Exploration	12, 000+	Pacific Ocean.
Phosphate	Exploration	(?)	Union of South Africa.
	Exploration	600–2, 400	Blake Plateau.
	Exploration	(?)	India.
	Exploration (inactive).	600±	California.
	Exploration	600—	Australia.
Phosphate sands	Exploration	600—	Mexico.
	Exploration	600—	North Carolina.
Sand	Dredging	300—	New England.
Shell sands	Dredging	150±	Iceland.
Shells	Dredging	30±	California.
Sulfide muds	Exploration	6, 000±	Red Sea.
Sulfur	Mining (Frasch)	60±	Louisiana.
Tin	Exploration	600—	Borneo.
	Dredging	150—	Indonesia.
	Exploration	600—	Malaysia.
	Dredging	150—	Thailand.
	Exploration	600—	Great Britain.
	Exploration	600—	Solomon Islands.
Titanium	Exploration	600—	Philippines.

[a] Dredging operations generally include exploration activity. Does not include mines originating on land and drilled out under the sea floor.

[b] Less than is represented by —; more than is represented by +; approximately is represented by ±.

Source: Department of the Interior.

3. The *Bureau of Land Management* prepares leasing maps, recommends and holds lease sales, issues leases, and approves assignments of lease interests. The Bureau also issues rights-of-way for pipelines and other needed facilities and furnishes technical information for securing final determinations of boundaries between Federal and State jurisdictions. Also, a new mineral economics group has been established to assist in development of land and OCS leasing and management policies. In 1968, 197 leases were issued and leasing activity in FY 1969 will include three drainage sales and a sulfur sale. In addition, calls for sale nominations have been issued in the Gulf of Alaska and off western Louisiana.

The *Geological Survey* is responsible for basic geological determinations and for administration of exploration and production activities, including surveillance of drilling and production to assure conformance to regulations, metering of production and collection of royalties, and determination of the efficiency of utilization. In 1968, approximately 420 geophysical permits and 25 core hole twinning permits were issued by the Geological Survey for exploration of the continental margins. Due to overlapping of permit areas, it is extremely difficult to quantify the area actually explored. It can be reasonably assumed, however, that the Gulf of Alaska, Bristol Bay, and lower Cook Inlet, off Alaska, were extensively explored, as were broad areas off all of the Gulf Coastal States and California, south of the Santa Barbara Channel. Portions of the remainder of the Pacific and the Atlantic continental margins were explored; however, they received less attention.

Three Areas of Increasing Emphasis

In FY 1970, 1,400 active leases are projected for the Outer Continental Shelf, an increase of 30 percent over FY 1969 and 52 percent over 1968. Industry estimates approximately 1,100 wells will be drilled and 700 new wells tested for production in FY 1970. In recognition of this increasing activity on the Continental Shelf, three areas of our marine science program deserve particular emphasis:

1. *A reevaluation of the legal-financial-administrative framework* for managing offshore oil and gas resources has been undertaken by the Department of the Interior. Under review are both the objectives of OCS leasing policy—the fundamental purposes to be achieved by leasing regulations—as well as the regulations and procedures themselves. The effectiveness of the latter is being evaluated through every stage in the leasing process—from initial exploration activities to the closing of a well—and alternative procedures are being considered in an effort to find those that will yield the

most efficient development of OCS resources at a fair market value and that will serve producer, consumer, and public interests most equitably. Particular attention has been given to leasing practices—timing of sales, procedures for conducting sales, size and tenure of leases, bonus and royalty terms—in the light of the expanding activities of the Shelf. This study will provide a basis for analyzing the views of all interested parties prior to determination of possible policy changes. Data on the geology, exploration, development, production, and anticipated national requirements of oil, gas, and sulfur on the OCS have been assembled as background for the review and will be published separately.

2. A more deliberate program of *environmental protection* is being developed. With regard to offshore oil exploitation, the Geological Survey will examine whether equipment is adequate to prevent release of oil into the oceans in case of disaster as well as during normal operations. Building on industry's widespread consciousness of the need to prevent pollution, increased attention will be devoted to determining that the design characteristics of support equipment and facilities provide for containment of oil spilled by accident or through equipment failure.

In the area of marine mining, the Bureau of Mines in cooperation with the Bureau of Commercial Fisheries will intensify studies (a) to develop an understanding of the ecological effects of potential mineral exploitation; (b) to improve understanding of the effects of mining technologies likely to be employed in selected environments representative of potential mining target areas, with particular emphasis on turbidity, sediment transport, and changes in bottom configuration; and (c) to develop a system of environmental monitoring to be employed when mining operations begin. Although this effort is primarily oriented toward preventing damage to marine life, emphasis will also be placed on possible beneficial side-effects of marine mining such as releasing trapped nutrients from mined sediments and using residual material for beach and shoreline restoration projects.

3. The importance of *prompt reconnaissance surveys* of the Shelf—as a guide to both resource development and to policy formulation—is clear. Knowing what is there is a necessary prerequisite to many decisions, public and private, national and international. Therefore, during the past two years the Marine Sciences Council has identified as an important next step the completion of geological, geophysical, and bathymetric mapping of the U.S. Continental Shelf at reconnaissance scale.

During FY 1970, resource appraisal activities of the Geological Survey are budgeted at $3.4 million. Bathymetric and geophysical mapping and other studies of ESSA, which directly contribute to resource mapping, are budgeted at nearly $13.6 million, and substantial contributions will be made by the Navy. The program also will include participation by universities, research institutions, and industry as well as the Federal Government.

Thorough analyses and maps are currently available for only a very small fraction of our Continental Shelf. In view of the rapidly increasing importance of geological, bathymetric, and geophysical information to the development and management of offshore resources, studies are planned by the Geological Survey and ESSA leading to the publication of maps of the following areas: (a) all of the Shelf at a reconnaissance scale of 1:1,000,000 or smaller utilizing information from all cooperating agencies, from private institutions, and from private industry as available; (b) the most significant areas of the Shelf at a scale of 1:250,000; and (c) selected areas of the Shelf of high economic potential at a scale of 1:62,500. A longer-range goal of ESSA is bathymetric and geophysical mapping of the entire Shelf at a scale of 1:250,000, a task requiring about 70 ship years. The maps will not only add impetus to private investment in offshore minerals, but will also provide an information framework for Federal management of offshore resources and a far more adequate scientific description of the Shelf than now exists.

Priorities for selecting areas and problems to be investigated for each region will depend on the results of analyses and offshore reconnaissance work and on knowledge of the adjacent dryland geology. Among the geological projects of particular interest are: several lines of drill holes along the Atlantic Shelf; reconnaissance core drilling off Washington-Oregon (petroleum); and intermediate scale mapping off southern New England (gravel, petroleum), the Carolinas (phosphates, petroleum), Washington-Oregon-California (earthquake hazard), and the Gulf of Alaska (petroleum). Also, the joint Geological Survey-ESSA mapping program in the northern Bering Sea will continue in 1969.

Mapping and resource delineation along our coasts could be one of the major activities during the early years of the International Decade of Ocean Exploration which is described in Chapter IX.

In no area of marine sciences is the necessity for and benefits from a public-private partnership more evident than in the development of nonliving resources. The resources will be developed by the private sector. At the same time the resources are on public lands and must be developed in the overall national interest. The policies and programs of the Federal Government must thus take into account the rapidly evolving technology becoming available to industry, the economic incentives that motivate private industry to move seaward, and the many factors that comprise the national interest in the development of public lands.

"To the spread of our trade in peace and the defense of our flag a great and prosperous merchant marine is indispensable."

—THEODORE ROOSEVELT

Chapter VIII
FACILITATING TRANSPORT AND TRADE

Waterborne transportation is an integral part of our national economy and is essential in support of national defense requirements. About 90 percent of our foreign trade of $56 billion per year moves by water. However, U.S. flag vessels currently carry less than 6 percent of our foreign trade tonnage, and projections indicate that this percentage will decline to less than 3 percent by 1980. This growing reliance on cheaper foreign carriers not only reduces the freight revenues accruing to the U.S. merchant marine and aggravates the balance of payments deficit, but also erodes our status as a world maritime power.

The advent of more efficient forms of ship transport—supertankers, containerships, barge-carrying ships—may result in slower growth in the number of vessels required to serve our waterborne trade and will be a major factor in planning the number and character of port facilities. Greater concentration of international shipment activities could result in changes in the pattern of port traffic on each ocean coast based on economies in shipping costs. These potential developments require urgent consideration of harbor and port redevelopment plans.

Trends toward specialized ocean transportation services are based on economies which depend heavily on technological innovations. Thus, marine research and development activities can assist in strengthening our maritime capabilities both at sea and in our port areas and enhance the position of the United States in world trade.

While there is broad agreement on the importance of a strong merchant marine—in the Executive Branch and Congress, and among shippers, union

leaders, bankers, and shipbuilders—there are widely divergent views on the remedy to reverse current trends. The Marine Sciences Act calls for "enhancement of transportation" and a brief abstract of some of the marine science considerations underlying a policy to foster a healthy merchant fleet is presented, recognizing that this program must be evaluated in the context of broad national transportation goals.

Supporting Maritime Transportation Development

The Departments of Transportation, Commerce, and Navy support research and development efforts related to shipping concepts, marine equipment, and advanced ship designs that can assist the maritime industry in improving its competitive position, aid national defense and emergency capabilities, and reduce government support costs. Funding for these programs is summarized in Table VIII–1.

Table VIII–1—Funding for Ocean Transportation

(In millions of dollars)

Activity and supporting agency	Estimated fiscal year 1968	Estimated fiscal year 1969	President's budget fiscal year 1970
Vessel and Port Technology [a]			
Department of Commerce (MARAD)	6. 8	4. 3	10. 1
Channel and Harbor Development Research [b]			
Army Corps of Engineers	2. 9	2. 7	2. 9
Safety, Navigation Aids, Pollution Control [c]			
Department of Transportation (Coast Guard)	1. 4	3. 6	5. 6
Total	11. 1	10. 6	18. 6

[a] Limited to R&D and scientific services; excludes funding for capital works or maritime subsidies, operations, and routine services.

[b] Limited to R&D, feasibility studies, and Great Lakes data collection and analysis; excludes about $200 million for channels, harbors, and other projects providing navigation, shore protection, and recreation support.

[c] Pollution control does not include funds of the Department of the Interior (FWPCA). These are included as a part of "Water Quality Enhancement" under Development and Conservation of the Coastal Zone in Appendix A-1, and amount to an estimated $4.9 million in FY 1968; $6.2 million in FY 1969; and $6.7 million in FY 1970.

Among the 1968 accomplishments of the research program of the Maritime Administration were:

—development of computer models and analytical techniques to evaluate transportation costs and ship designs;

—recommendations concerning shipboard and shoreside maintenance management;
—recommendations for use of mobile, self-powered hydraulic cranes on break-bulk cargo liners;
—design of a standard propulsion plant adaptable to any combination of maritime nuclear reactor and propulsion machinery currently available; and
—demonstration of ship-to-shore voice communication via satellite with a merchant vessel (with cooperation of Navy).

The Maritime Administration plans to devote $10.1 million to marine science activities in FY 1970 as follows:

—studies of new technology to reduce shipbuilding and port costs ($0.4 million);
—research in hydrodynamics, thermodynamics, and structural dynamics to reduce ship operating costs ($2.7 million);
—investigation of new ship concepts to determine the technical and economic feasibility of promising advanced marine vehicles and their associated facilities ($5.8 million); and
—studies of ship design related to value engineering, ship performance, automation, and new types of equipment ($1.2 million).

Contributions of the Coast Guard to facilitating safer maritime shipping practices in 1968 included:

—static and dynamic experiments, both with models and aboard ship, concerning loading and behavior of bulk grain aboard ship leading to revision of international regulations concerning such cargoes;
—completion of studies and consultations with private interests demonstrating the need for legislation requiring bridge-to-bridge radio telephone communications capabilities for certain classes of vessels;
—beginning of construction of a shipboard fire safety testing facility in Mobile, Alabama, and U.S. acceptance of new international fire safety standards for ship design;
—inspections of several vessels under construction in foreign shipyards for U.S. registry to facilitate certification on arrival in the United States; and
—development of standard survival-at-sea packages together with aerial sighting and delivery systems.

Also, legislation was introduced (S. 3751 and H.R. 18537) to update and unify all the various U.S. Rules of the Road that have evolved during the past 100 years, and the International Load Line Convention entered into force in 1968.

A new system of sea lanes, similar to divided highways and designed to reduce the incidence of collision in dense traffic areas, was established in the Southern California area on January 1, 1969, following successful experi-

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ence with sea lanes at the approaches to New York Harbor, Delaware Bay, and San Francisco. Sea lanes are projected for Cook Inlet and the Chesapeake Bay. Also, a system of fairways leading to all of the principal U.S. ports in the Gulf of Mexico has been established. These sea lanes and fairways are being delineated on all appropriate coastal charts being prepared by ESSA.

Channel and Harbor Improvement

The Corps of Engineers has primary responsibility for construction, maintenance, and protection of channels and harbors [1] and supports research in such areas as channel hydrodynamics, shoaling, stability of breakwaters and jetties, silting of ship channels, harbor surges, wave dynamics, currents, and sediment movement.

The development of new dredging techniques and equipment to keep pace with dredging requirements for deeper navigation channels and increased pumping distances to disposal areas should receive particular attention. The Corps has 57 coastal channel and harbor improvement projects currently underway, for which the total Federal costs are estimated to be $1.09 billion.[2] Congress has authorized (but not funded) another 90 projects, to cost an estimated $1.1 billion.

Even with these planned improvements, however, many existing channels will not be adequate to accommodate the deeper draft tankers and dry bulk vessels now operating. These newer vessels and further technological advances will necessitate new or improved channel and harbor facilities. The need for dredging may be reduced by development of ports on a regional basis or by construction of offshore terminal facilities.

Improving Navigation Aids

The Marine Sciences Council endorsed as a priority effort development of a national plan for navigation, currently being prepared by the Department of Transportation (Coast Guard and Federal Aviation Administration),

[1] There are now 500 commercial harbors with depths up to 45 feet, approximately 250 small craft harbors, and about 23,000 miles of inland and intracoastal waterways.

[2] Major individual projects are New York Harbor, Chesapeake and Delaware Canal, Mississippi River at the Gulf Outlet, the Sacramento River, connecting channels in the Great Lakes, and Cross-Florida Barge Canal.

taking into account current and future needs of aviation and maritime commerce and advanced technology of navigation satellites and electronic ground-based systems. The plan will identify areas of Federal responsibility for navigation services, the systems to be operated by the Federal agencies, and the needed research and development efforts to meet future navigation requirements. Charting needs will also be considered.

The following activities were undertaken in 1968 by the Coast Guard in developing the national plan:

—identification of current and future requirements for navigation aids, available and projected technologies, alternative system configurations, and economic analysis methodology—all related to navigation near our coast and on a global basis;

—consultations with industry, port authorities, pilot associations, and other non-Federal groups to gain their views on navigation problems and priorities;

—preparation of an inventory of end-user investments in navigation equipment and initiation of cost/benefit evaluations of alternative navigation systems; and

—review of policy issues related to (a) private electronic aids to navigation, (b) uniformity in navigation standards, and (c) possible new approaches to funding including local financing and user charges.

Complementing the development of this national plan are continuing efforts to improve navigation along our coasts and in distant waters. The following research and development activities in 1968 contributed to our national capabilities:

—testing and evaluation of the LORAN D system which provides precise positioning needed for detailed coastal surveys;

—testing of the medium range, highly accurate TRANSLOC system which is easily transportable and can operate unattended;

—development of floating navigation aids including improvement of plastic buoys and high strength mooring chains;

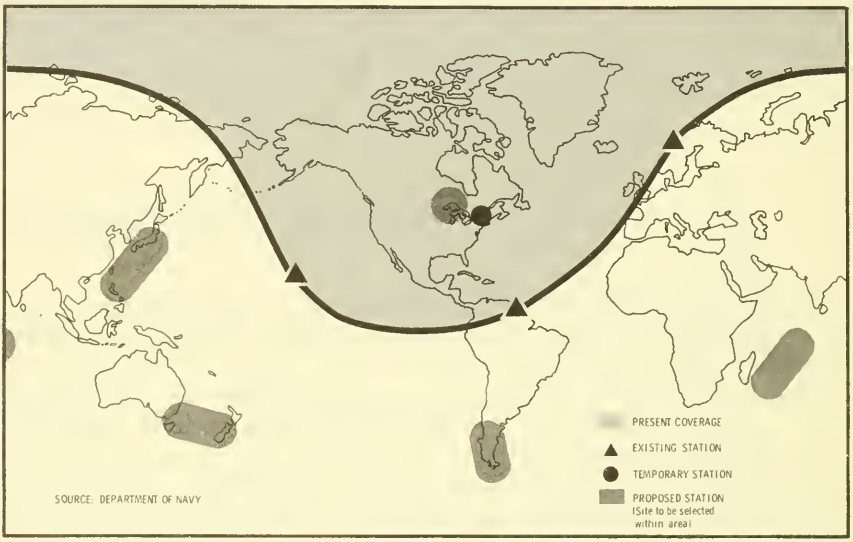
—development of power systems and mooring and servicing techniques for unmanned platforms to replace lightships; and

—exploratory development of a short-range, high precision all-weather navigation system for harbor approaches.

Concurrently with these efforts, maintenance and improvement of nautical charts is carried out by ESSA. Surveys of charted waters, followed by compilation of information on depths, cultural and topographic features, and the position and characteristics of navigational aids, assure safe navigation in coastal waters.

Also, the Navy has completed plans for installation of the advanced OMEGA system on a worldwide basis (Figure VIII–1) which will contrib-

Figure VIII–1—Present Coverage and Proposed Future Sites for OMEGA Navigation System



ute to civilian as well as military shipping. The first demonstration and test of satellite capability in conjunction with the Navy OMEGA system to locate and position a ship with relatively good accuracy was carried out during the past year.

Research and Action To Reduce Pollution

Following the *Torrey Canyon* oil spill off the southwest coast of England in 1967, the President directed the Departments of Transportation and the Interior to prepare recommendations for a national program to deal with the hazards of oil spills from oceangoing transportation, including policies, procedures, and programs to prevent disasters from hazardous cargoes and to mitigate the damage ensuing if a disaster occurs. As shown in Figure VIII–2 a similar spillage involving the *Ocean Eagle* in San Juan harbor in March 1968 emphasized the importance of these recommendations, which had just been released, and pointed out the role of multi-agency contingency plans to insure the prompt and efficient mobilization of national resources in the event of such disasters.

On the recommendation of the Marine Sciences Council, the President asked the Secretary of the Interior immediately to assume primary responsibility for completing at the earliest possible date multi-agency contingency

plans for responding to pollution emergencies involving oil or hazardous materials with the understanding that he would work closely with the Secretaries of Transportation and Defense in this effort. In the event of an emergency prior to completion of these plans, the Coast Guard was to assume on-site command responsibility. Also, an ad hoc committee of officials of the Executive Office of the President was established to review the development of the plans.

In the fall of 1968 the President approved the *National Multi-Agency Oil and Hazardous Materials Pollution Contingency Plan* which established a pattern for a coordinated response among the Departments of the Interior, Transportation, Defense, and Health, Education, and Welfare, and the Office of Emergency Planning in the event of an oil pollution emergency. It establishes a national reaction team and provides guidelines for the establishment of regional contingency plans and reaction teams. A standing National Inter-Agency Committee will continue to plan the Federal multi-

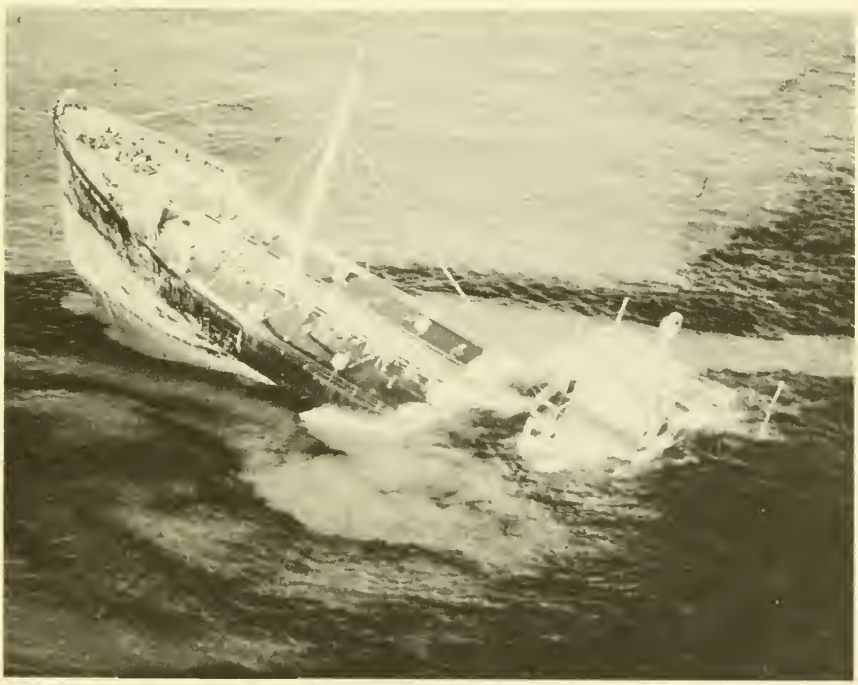


Figure VIII–2—*Grounding of the 12,000 gross ton oil tanker OCEAN EAGLE off San Juan Harbor in March 1968 is one of a series of recent oil pollution incidences emphasizing the importance of intensified research and development and improved regulation and enforcement procedures to reduce the possibilities of damage from massive oil spills.*

agency response to pollution incidents; define procedures to promote the coordinated reaction of all Federal, State, local government, and private agencies to pollution incidents; and consider training of reaction team personnel, research, development, and test and evaluation activities needed to support reaction capabilities, and equipment and material stockpiling. A Joint Operations Team will be activated in the event of a pollution incident which (a) exceeds the response capability of the region in which it occurs, (b) transects regional boundaries, or (c) involves national security or a major hazard to substantial numbers of persons or nationally significant amounts of property. This team will act as the focal point for national public information releases and for information transfer between the on-site teams and Washington.

The National Contingency Plan provides guidelines for the establishment of regional contingency plans and reaction teams and encourages the development of local government and private capabilities to handle pollution incidents. Coordination and direction of Federal pollution control efforts at the scene of a pollution incident will be accomplished through a single executive agent predesignated by regional plans. The Coast Guard will furnish the predesignated Commander for the coastal and contiguous zone waters, ports, and harbors, Great Lakes, and major inland navigable waterways, and the Department of the Interior will designate the Commander in other areas. The plan incorporates procedures to make effective use of the ESSA's prediction services related to tides, winds, river flow, and sea state that can affect dispersion of oil and other pollutants.

Complementing the development and implementation of the National Contingency Plan will be FY 1970 efforts of the Coast Guard, Corps of Engineers, and Federal Water Pollution Control Administration to strengthen our capability to detect, contain, and ameliorate spills of oil and other hazardous cargoes. Research efforts endorsed by the Marine Sciences Council include development of:

—procedures and equipment for containment of oil spills at the source and in open and rough water;

—techniques for removal of cargoes from troubled vessels using high capacity air transportable pumps and oil burning technologies, and development of booms and other devices that can be quickly rigged and emplaced;

—procedures and equipment for the recovery of spilled pollutants before they befoul the coast or create fire or safety hazards; consideration will be given to complement existing pumping technology with flotation devices including appropriate pipelines and containers and with specially designed tankers or other vessels to serve as bulk containers;

—methods of tagging pollutants in order to identify the source and provide a basis for recovering clean-up costs;

—information on the source of pollutants in the ocean including a review of current standards governing oil discharges;
—procedures to protect central areas and shorelines including investigation of the feasibility of (a) sand-filled nylon bags to serve as dikes, (b) large rubber, plastic, or polyethylene sheets anchored on critical beach areas, and (c) beach skimming devices with capability of separating sand from the pollutants; and
—procedures for increasing safety in harbors, including establishment of (a) port advisory services, including radio broadcasts of navigational information, marine traffic activities, and emergencies—with experimental service initiated in San Francisco, and (b) a national information center on hazardous cargoes moving in water transportation, their properties, effects if accidentally released, and protective measures to be taken in the event of an accidental release.

The proposed funding levels for FY 1970 for these activities are FWPCA—$1.7 million, Coast Guard—$2.6 million. The Corps of Engineers will participate as appropriate.

In addition to the preceding work on corrective aspects, the Coast Guard has initiated a program of research and regulatory action to prevent pollution by ship cargoes. Special emphasis is being placed on chemicals because of their great potential hazard and the present lack of knowledge about their behavior in the marine environment. The program includes the following activities:

—development of new regulations for bulk chemical carriers with design requirements based, in part, on pollution potential of the cargoes;
—revision and extension of the recent *Guide to Hazard Evaluation of Chemicals in Bulk Water Transportation;*
—sponsorship of a Bureau of Mines investigation of the behavior and hazards of massive releases of extremely cold (−258° F) liquefied natural gas into water in the event of a vessel casualty; and
—control of foreign vessels desiring to carry unusually hazardous cargoes into and out of U.S. ports and development of international standards for bulk chemical carriers.

Preparing for Port Development and Redevelopment

Future requirements for U.S. ports and harbors will probably be characterized by:

—limitations on costly channel improvement projects and concentration of very large bulk vessels at a limited number of deep water ports constituting major bulk cargo transshipment centers;

—innovative offshore or outport terminals to accommodate supertankers, with such individual terminals to be capable of supplying their immediate region or other harbor regions by pipeline, barge, or small tanker (Figure VIII–3);
—concentration of international containership operations in a few major load center ports on each ocean coast; and
—concentration of major ocean barge-carrying ship operations in a few load center ports.

Figure VIII–3—*The world's largest ship, the 312,000 DWT SS UNIVERSE IRELAND, berthed at the world's newest offshore oil loading facility ten miles off the coast of Kuwait. The facility is connected to shore by a 48-inch crude petroleum submarine pipeline and a 20-inch bunker fuel oil submarine line.*

In recognition that these trends must be considered in future port planning and may necessitate the development of specialized ports and integration into the overall transportation system, a multiagency research effort has been directed toward development of a conceptual plan for harbor and port development studies. The general objectives of the needed studies and possible division of work among the Federal agencies have been considered and preliminary order-of-magnitude estimates of time and cost made. It is firmly recognized that these studies must be performed as a coordinated effort with States, municipalities, and other non-Federal entities. Prior to adoption of such proposals, extensive consultations are being held with all interested parties.

Among the other areas of emphasis in FY 1970 which directly complement this major study effort to facilitate maritime activities in and near our ports are:

—studies of specific types of bulk cargo transfer facilities including offshore ports and artificial islands, isolated shore locations, ship-to-barge transfer, ocean barge systems, and submarine tankers; and

—analytical and experimental underwater soil mechanics studies related to construction of artificial islands, causeways, harbors, floating breakwaters, and other structures.

While advances in science and technology will continue to contribute to more efficient maritime activities, changes in the institutional framework appear essential if major progress in strengthening the maritime fleet is to be realized. Administration proposals on maritime shipping policy to the 90th Congress have not elicited the necessary support, nor have Congressional proposals had Executive Branch support. Nevertheless, the importance of the merchant fleet to our entire oceanic endeavor and the efficient expenditure of public and private funds warrant a new concerted effort by all participants to resolve differences and develop policies that will contribute to economic growth, our international maritime presence, and our national defense requirements.

". . . the science of abyssal research cannot, from its nature, advance slowly and gradually; it must proceed by strides . . ."

—H.M.S. CHALLENGER EXPEDITION, 1885

Chapter IX

LAUNCHING AN INTERNATIONAL DECADE OF OCEAN EXPLORATION

Following a call for broadened international cooperation in ocean exploration in his *State of the Union* message, President Johnson on March 8, 1968, proposed the launching of "an historic and unprecedented adventure—an International Decade of Ocean Exploration for the 1970's." Recognizing a rapidly growing wordwide interest in exploiting ocean resources, the importance of understanding ocean processes, and the value of conducting ocean investigations as a multinational enterprise, he urged that all nations join together in a concerted, long-term, cooperative program of ocean exploration on a worldwide basis. He emphasized that such a program could:

—"expand cooperative efforts by scientists from many nations to probe the mysteries of the sea;

—increase our knowledge of food resources, to assist in meeting worldwide threats of malnutrition and disease;

—bring closer the day when the people of the world can exploit new sources of minerals and fossil fuels."

The Decade is envisioned as a period of intensified collaborative planning among nations and expansion of exploration capabilities by individual nations, followed by execution of national and international programs of oceanic research and resource exploration so as to assemble a far more comprehensive knowledge of the sea in a reasonably short time.[1]

[1] The Council report "International Decade of Ocean Exploration," May 1968, has been distributed throughout the United States and abroad as a basis for discussion of the concept of the Decade at international and national meetings.

The Decade should contribute to the economic and scientific development of all participants. Data about distribution and richness of resources, particularly new sources of food critically needed in the developing areas of the world, should accelerate their development. Thus, emphasis should be placed on identification and assessment of food and mineral resources as well as on investigation of natural ocean processes.

Existing patterns of effective scientific cooperation provide experience on which to develop expanded and more systematic efforts of the future. The success of such an endeavor will depend in large measure on the extent to which various nations contribute their particular expertise and capabilities, assume a share of responsibility for the program, develop their manpower and facilities, and disseminate to others the results of scientific and other discoveries.

Effective exploration of the oceans can best be achieved through both research and surveys, balanced to solve specific scientific problems and to systematically collect data on a broad regional or world ocean basis. The Decade does not by any means suggest exploration of every square mile of the world's ocean, nor investigation of every conceivable ocean phenomenon. However, during the Decade the nations of the world can identify the most promising geographical areas and lines of scientific inquiry, set priorities, and agree on distribution of effort.

The Decade is not merely a continuation of past efforts but has several unique aspects. The proposal:

—anticipates a sustained, long-term exploration of the sea, planned and coordinated on a global basis, in contrast to the sporadic efforts of the past, developed project by project;

—is oriented as much toward delineation of marine resources as toward science, and is thus broader than past scientifically oriented oceanographic research programs;

—envisages more deliberate coordination of the many interested international organizations, such as the Intergovernmental Oceanographic Commission, Food and Agriculture Organization, and World Meteorological Organization so that planning and coordination of worldwide exploration will not be unnecessarily splintered among competing agencies; and

—foresees an intensified effort toward more systematic collection of data and prompt dissemination, with particular attention to adoption of internationally agreed-upon standards to maximize the value of the data as a commodity for exchange. As more sophisticated data processing equipment comes into use, particular attention should also be given to the compatibility of national data collection and processing techniques and to common procedures for calibrating oceanographic instruments.

Finally, participation by a larger number of countries in ocean exploration is being encouraged, especially those which have a maritime geography but which may have previously lacked interest, trained manpower, or capabilities to explore the oceans, even near their own shores. In this way, developing nations should be able to share the capabilities of the more developed countries, to acquire contemporary technology for their own use, and to increase opportunities to identify contiguous marine resources.

Illustrative Types of Projects and Objectives

As a point of departure for international discussions, consideration might be given to the following kinds of projects:

—surveys of selected ocean areas, principally from oceanographic ships, complemented by increasing use of other platforms such as spacecraft, buoys, submersibles, and ships of opportunity;

—intensive study of designated ocean areas of limited expanse;

—research directed to specific ocean phenomena;

—development of improved worldwide (a) instrument calibration, and (b) data collection, processing, storage, and distribution facilities and services to facilitate international exchange of data;

—assistance in strengthening the technical capabilities of the developing nations to participate in exploration programs, including manpower training; and

—provision of precise navigation aids and use of other advanced technological capabilities.

Illustrative of the types of objectives for such collaborative endeavors that might be considered internationally are these examples:

1. *Exploration of Living Resources*

—assessment of living resources useful to man in poorly charted regions of the world ocean;

—assessment of current utilization of known fishery stocks; and

—acquisition of knowledge relating living resources to their environment in order that greater efficiency in their capture and conservation can be achieved.

2. *Exploration of the Ocean Floor*

—determination of the geological structure and mineral and energy resource potential of the world's continental margins;

—preparation of topographic, geological, and geophysical maps of selected areas of the deep ocean floor; and

—coring and drilling on the continental margins and deep ocean floor in selected areas.

3. *Exploration of Ocean Processes*
   —study of scales of motion in the sea, temperature variations, and the dynamics of ocean current systems;
   —investigations of various surface boundary processes, such as the growth and propagation of ocean waves; and
   —investigations of evolutionary processes of ocean basins.
4. *Assistance to the Developing Nations*
   —mapping of selected areas of the Continental Shelf of developing nations; and
   —surveys of the coastal fishery resources of the developing nations.

In preparing the concept of a Decade, the United States has not attempted to prejudge the scope, specific international projects, nor the international planning and coordinating arrangements. Interested nations and international organizations should work out these details collaboratively. The United States therefore has initiated discussions with nations throughout the world on the concept of the Decade.

Enhancing International Collaborative Programs

International scientific cooperation has been widespread in oceanography for many years. It is against this background of scientific interest and experience in collaborative projects that a long-term continuing program of exploration, worldwide in character, would be built. Current programs sponsored by international organizations, together with existing and planned bilateral and multilateral cooperative exploration endeavors, would provide an excellent starting point for the Decade.

Figure IX–1 shows the relative density of one type of ocean exploration activity conducted throughout the world to date.

During the late 1950's, the International Geophysical Year was a major stimulus in expanding earlier efforts, and since that time a number of collaborative ocean exploration projects have been developed and successfully carried out, e.g., the International Indian Ocean Expedition, the International Cooperative Investigation of the Tropical Atlantic, and the Cooperative Study of the Kuroshio. Their success has encouraged present consideration by the Intergovernmental Oceanographic Commission of new cooperative programs in the Caribbean and Mediterranean Seas and in the North Atlantic and Southern Ocean which can provide initial building blocks for the Decade.

Surveys and assessments of fishery stocks in Asia, Africa, and Latin America, supported by the Food and Agriculture Organization, are having a significant impact on economic development in those areas. A number of

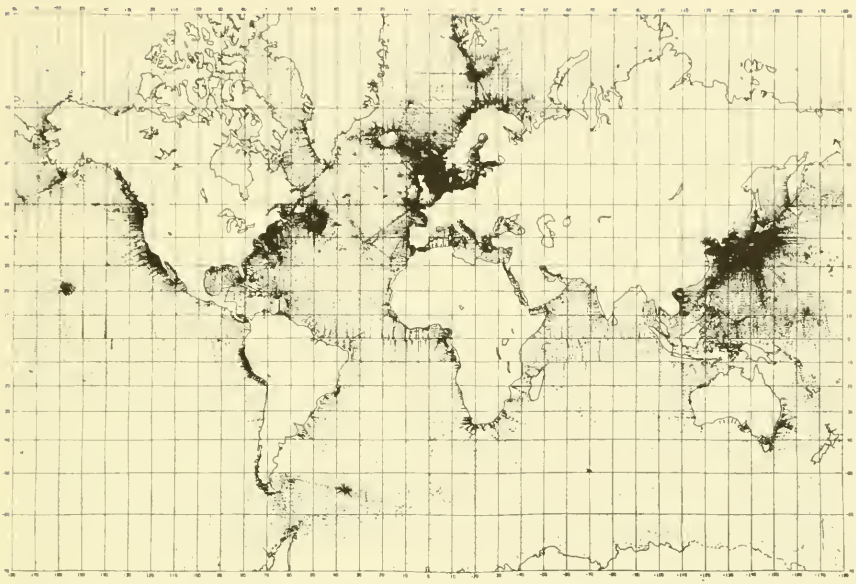


Figure IX–1—*A computer-generated plot of the location of oceanographic data stations where Nansen casts have been made illustrates the geographical coverage of ocean exploration activities to the present. Physical-chemical data from the 363,752 stations are filed at the National Oceanographic Data Center. Data come from many nations.*

important international fisheries are being successfully conserved through the programs of international fishery commissions. Furthermore, limited studies carried out by the commissions are contributing to our understanding of world fishery resources.

Of particular importance to the success of many international endeavors has been the contribution of non-governmental scientific organizations and institutions in developing the scientific basis for many programs and taking part in their implementation, especially through the International Council of Scientific Unions. Direct and personal arrangements between the scientists of different nations have similarly added to the international storehouse of knowledge.

Adoption of a Resolution by the U.N. General Assembly supporting the Decade highlighted the broad support the proposal has received during the past year (Chapter III).

The following U.N. bodies have also supported the Decade:

Economic and Social Council

Ad Hoc Committee on the Seabed

Bureau and Consultative Council of the Intergovernmental Oceanographic Commission

Executive Committee of the World Meteorological Organization and its Commission for Maritime Meteorology
Council of the Food and Agriculture Organization

In addition bilateral discussions were held with many coastal States concerning the proposal and the response was universally favorable. The Council's Executive Secretary traveled to Moscow, London, Bonn, and Oslo to elaborate on the proposal, and also discussed details in Washington with officials from a number of other countries.

Consultations to formulate specific national commitments will be a continuing and lengthy process. The positive interest of a substantial number of governments was indicated by the cosponsorship by 28 nations of the U.N. Resolution endorsing the Decade. Many are well aware of the need for careful preparatory planning, including the identification of specific areas for investigation, but would like to avoid a proliferation of new international bodies for implementation of the Decade. Also there is a recognition of the need to continue and expand bilateral and regional arrangements, where appropriate, within the overall context of the Decade.

Three important steps are now required internationally to implement the Decade concept:

—development of a multinational organizational framework for planning and cooperation;
—identification of specific projects to be carried out; and
—commitments by individual nations of their individual exploration capabilities to cooperative endeavors.

Developing National Programs

During the Decade all nations would be encouraged to identify how the oceans can contribute to their own scientific and economic development, and accordingly:

—develop their capabilities for exploring the oceans;
—expand national ocean exploration programs; and
—share with other nations experience and scientific data acquired from these national programs.

At the present time most nations are primarily interested in ocean exploration programs close to home shores—exploration of the Continental Shelf and of coastal fishery stocks—and these programs receive the bulk of national financial support. Even though nations are moving farther out to sea every year, in the near future much of the world's ocean exploration activity will probably continue to be coastal, of interest primarily to individual nations. However, sharing of experiences and data can benefit others. Of course,

the greatest benefits are derived from the pooling of resources and the sharing of responsibilities through planning and implementing specific collaborative projects. This is particularly true in the deep oceans where, because of the high cost of operations, it is desirable to coordinate plans internationally to insure that areas with the highest potential interest to the most users are given priority attention.

Planning in the United States

In the United States, the National Council on Marine Resources and Engineering Development has been assigned the responsibility by the President for coordinating on a government-wide basis ocean exploration activities and for developing a coordinated national exploration plan. As an initial step, the Council has turned to the scientific and engineering communities to assist in developing specific proposals. The Council contracted for the National Academy of Sciences and National Academy of Engineering to conduct a study and prepare recommendations concerning:

(1) scientific and ocean engineering goals for the Decade;

(2) priorities among these goals;

(3) capabilities required to achieve these goals in terms of manpower, marine data (including standards as appropriate), instrumentation (including calibration as appropriate), sea and shore facilities, and funds;

(4) program elements of the Decade including objectives, milestones, priorities, and timing; and

(5) end products of the Decade such as charts, maps, research reports, atlases, and benefits to be expected in terms of advancements in science and engineering as well as contributions toward the goals and objectives of P.L. 89–454.

The Academies have preliminarily identified the following exploration programs to be of particular interest during the next ten years:

1. *Geology and Non-Living Resources:*

—geological-geophysical surveys of North American Continental Shelves and the eastern Atlantic continental margin;

—assessment of the mineral resource potential of small ocean basins, such as the Gulf of Mexico, Caribbean, Mediterranean, and the East Indies area;

—dredging, coring, profiling, and related studies of oceanic ridges and trenches, such as the Mid-Atlantic Ridge and the Peru-Chile Trench; and

—surveys of selected Pacific sites of manganese nodules and phosphorite deposits.

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2. *Fisheries:*
   —assessment of the fisheries production potential of the Gulf of Mexico, Gulf of Alaska, and equatorial eastern and central Pacific;
   —ecological and related studies leading to improved management of fisheries of the northwestern Atlantic;
   —assessment and increased development of fishery resources of the Arabian Sea, offshore southern Chile and Argentina, and in the Indonesian Archipelago; and
   —investigation of the potentially rich euphausiid resources of the Antarctic Ocean.
3. *Biological Studies:*
   —application of recently developed techniques to studies of food chains in the sea; and
   —development of new techniques for measuring biological factors and for modeling ecosystems using computers for areas such as Georges and Grand Banks, the Gulf of Alaska, the Gulf of Mexico, the eastern and central equatorial Pacific, the South Pacific gyre, the western Arabian Sea, and the Antarctic Ocean.
4. *Physics and Environmental Forecasting:*
   —investigation of 1,000 to 3,000 mile, cold and warm anomalies related to "centers of action" in the North Pacific;
   —studies of large-scale, long-term air-sea interaction and meso-scale interaction in subtropical upwelling regions;
   —systematic ocean coverage of deep temperature, salinity, and oxygen measurements; and
   —geochemical "benchmark" surveys of selected trace substances on meridional traverses in the Atlantic, Pacific, and Indian Oceans.

The Academies' final report will be released by the Council this year to assist in further development of the Decade concept, both nationally and internationally. This report, together with the Ten-Year Plan for Ocean Exploration which is being developed as described in Chapter XII, will be used in government-wide Decade planning. Additionally, economic analyses of the benefits to be derived from alternative types of Decade programs will be conducted. Also, representatives of the major non-Federal industrial and scientific interests concerned with ocean exploration will have an opportunity to review Decade plans on a continuing basis, thus providing for broad national participation in the development of the program.

As a first step, those types of on-going programs that will contribute to accelerated exploration activities during the Decade and the most promising areas for new program emphasis during FY 1971 will be identified. Also, efforts will be made to identify long lead-time items such as ships and data processing equipment that might require funding early in the Decade.

At the present time the United States supports many Decade-related programs through about 30 percent of the Federal marine science budget. About

half of these programs are of broad international interest. The scale and pace of development of internationally oriented ocean exploration programs by the United States will depend in large measure on the international interest and participation in the Decade and the benefits that are derived from the collaborative programs as they develop. If the Decade is broadly supported on an international basis, it is likely that the expenditures will increase more rapidly during the later years of the Decade than during the early 1970's as the mobilization of the resources of many nations accelerates.

In the Legislative Branch, Senate Concurrent Resolution 72, adopted last year by the Senate, sets forth objectives and expectations of the Decade.[2]

[2] The Resolution is included in Appendix B–4.

"Science can only give us the tools in a box . . . but of what use to us are miraculous tools until we have mastered the human, cultural use of them?"

—FRANK LLOYD WRIGHT

Chapter X

ADVANCING THE SEA GRANT PROGRAM

Progress in marine sciences in the 1970's depends in large measure on an expanded base of manpower, especially engineers and technicians, broadened applied research capabilities, and improved mechanisms for information transfer. The National Sea Grant College and Program Act (Public Law 89–688), which was signed into law on October 15, 1966, was a major innovative step to meet our future needs, and the President has emphasized the importance of this new partnership between the Federal Government and the Nation's universities. The Sea Grant Program can become a cornerstone of long-term investments to strengthen our capabilities through multidisciplinary approaches to marine resource development. The program augments existing programs with special emphasis on developing regional capabilities to work on regionally oriented problems.

The Sea Grant Act charges the National Science Foundation with initiating, developing, and supporting Sea Grant programs. The legislation directs the Marine Sciences Council to advise the Foundation with respect to policies, procedures, and operations.

The Sea Grant Program has three explicit objectives:

—to accelerate training and education of specialized manpower, especially ocean engineers and technicians required by industry and government which are not being developed through existing programs;

—to initiate and support applied research, in predevelopment stages, particularly related to recovery and use of marine resources; and

—to disseminate knowledge and information about marine resource development to all interested and concerned sectors of the Nation through extension and advisory services.

To accomplish these objectives, there are two modes of support, institutional and project. *Institutional* support is intended to help selected academic institutions evolve into a network of "sea grant colleges" with a wide range of environmental, economic, and technological orientations. These institutions will be expected to provide regional leadership in ocean research and development, and serve as the "seed bed" for a growing national program. Moreover, sea grant colleges, with university-wide commitment to the objectives of the program, can develop the needed competence to deal with applied marine research problems on a much broader interdisciplinary front through the blending of social science skills, particularly in law and economics, with those from the engineering and natural sciences. Sea Grant *Project* support is directed to individual projects related to marine resource development. Such projects can involve specialized scientific or engineering research, studies, education, advisory, or training activities.

As a matter of policy, the Council and Foundation have agreed that the Sea Grant Program should be largely oriented to national purposes, such as those dealing with food from the sea, ocean-related environmental forecasting, Continental Shelf exploitation, and multiple use of the seacoast. Thus, many government agencies can participate in and benefit from the program. For example, ESSA has taken preliminary steps to establish regional marine specialists at sea grant colleges, and the Bureau of Commercial Fisheries participates in aquaculture projects supported by the program.

The Long-Term Policy Framework

The following general policies and guidelines have been established to implement the Act:

1. *Geographic Factors*—Geographic dispersal of institutional and project support is considered in evaluating Sea Grant proposals. Proximity to seashore and ocean access, while clearly enhancing pursuit of certain types of marine research, is not a requisite to participation in some aspects of the program. In accordance with the Act, obligations made through grants or contracts to institutions in one State in any fiscal year may not exceed 15 percent of the total amount appropriated in that year.

Six Sea Grant institutions are now supported by NSF. As additional capabilities are mobilized, one might be established in each coastal and Great Lakes State or region if better served collectively. In addition to considering

support for sea grant colleges according to local and regional needs, support will also be given to institutions specializing in programs of particular nationwide importance.

2. *Cooperative Efforts*—Participants in the program are being encouraged to undertake cooperative programs with other institutions, with business and industry, with State and local governments, and with Federal laboratories. A major goal of the program is to mobilize collective resources, foster local channels of communications, and establish new patterns of collaboration beyond the limits of any single Sea Grant institution.

Industrial firms in widely diverse fields can participate in the program, enabling students to pursue on-the-job training in conjunction with their normal educational programs. Industrial requirements can help to shape the direction of the program and, indeed, the NSF looks to industry for suggestions and ideas essential to planning. Thus, the Sea Grant Program can help to support existing industries through provision of trained manpower, new techniques, and concepts.

3. *Emphasis on Applied Activities*—While basic scientific studies will be supported if the eventual application of results seems reasonably clear, applied research, including legal, economic, sociological, business administration, and similar fields important to marine resource development or utilization are being stressed.

4. *Manpower Training*—There is a corresponding emphasis on training engineers and technicians. Institutions receiving Sea Grant support either directly for education and training or indirectly through support of research or development projects involving graduate assistants may, by 1975, be instrumental in turning out annually 100 to 300 ocean engineers at the graduate level, 100 to 300 ocean engineers at the bachelor's level, and 500 to 900 ocean technicians. Thus, within the next decade, available technical manpower could be doubled over a broad spectrum of disciplines.

5. *Need for Innovation*—The intent of the Act would not be fulfilled by strict adherence to traditional approaches in research or resource development. The Nation's academic institutions have contributed substantially to imaginative and productive innovation in other fields of endeavor, and this trend will be nurtured in the development of marine resources.

6. *Matching Costs*—To stimulate local and regional involvement and commitment, the Act stipulates that the total amount of Federal payments under a grant to or contract with a participant in the program shall not exceed 66⅔ percent of the total cost of the program. For the purpose of computing the amount of matching funds, the salaries, supplies, and indirect costs provided by the participant from non-Federal sources are included. Sea Grant funds may not be used, however, for the purchase or rental of any land or the rental, purchase, construction, preservation, or repair of any building, dock, or vessel.

7. *Industrial Participation*—The Sea Grant Program is also attempting to encourage industrial involvement in several ways. While industry is not funded directly, cooperative programs between institutions and industry are feasible. In some instances, funds or facilities might be provided by industry to an institution conducting a Sea Grant Program. This arrangement assists the institution in providing the necessary matching funds and the resulting research data and manpower can help meet industry's needs. In other instances, a firm's specialized facilities may be used in either research or education programs by a participating institution.

Criteria for Sea Grant Support

Institutional support is intended to assist institutions of higher education which have broad-based competence and interest in ocean science and education to further strengthen this base through additional major programs devoted to increasing utilization of marine resources—both in the institution's geographic region and in the Nation. Activities receiving institutional support may involve any schools or departments of a university or college which can contribute to achieving Sea Grant objectives, in addition to schools or departments engaged in activities commonly associated with the marine environment. For example, consideration can be given to a school of law through study of the legal aspects of marine resource development; a medical school through study of various aspects of the physiology and human engineering of marine resource recovery techniques; a school of pharmacy through programs in the field of marine pharmacology; a department of journalism through specialized advisory services; a home economics department through home utilization of marine foods and advisory services most useful to homemakers; and schools or departments of business administration, economics, sociology, psychology and political science through marine resource development studies emphasizing the contributions of these disciplines.

Criteria for determining institutional awards include:

—a history of significant, marine-related activities in research and education, and demonstrable success in those activities;

—availability of the necessary facilities including laboratories, ships, and docks;

—a capacity and an intention of the host institution to adopt the Sea Grant mission as a major goal, as demonstrated among other things by the full commitment of responsible senior officials to the program, including a full-time program director/coordinator;

—a staff recognized in the marine community for leadership and scholarship, including regular participation by faculty from allied departments;

—ability to match the Federal contribution by providing at least one-third of the cost of Sea Grant activities;

—a defined study curriculum, capacity for growth, the ability to plan and execute a complex program of high quality, and provision for multi-institutional collaboration; and

—location in a region with marine related industry with planning devoted at least partly to regional problems such as utilization of local marine resources.

Sea Grant Project support is intended to advance scientific, engineering, and technological know-how, especially at the stage where scientific discovery first blends into a possible social application, but also where practical economic benefits are still uncertain. This mechanism also provides a means for responding to varied and changing research needs of the Federal Government. It is of particular importance in complementing programs of agencies not having broad extramural programs and in supporting research on topics crossing agency lines that fails to gain strong single agency advocacy. Support in this category can encompass more than research. The legislation also permits support of symposia and conferences for the development of innovative educational curricula and for new programs needed for training of critical or specialized technological skills.

Public or private institutions of higher education and other institutions, laboratories, and public or private agencies may be eligible for Sea Grant Project support. Criteria on which awards are based include:

—the merit of the project and its potential for contributing to the broad objectives of the national Sea Grant Program;

—the proposing institution's demonstrable competence and experience in the project field, or in a closely related field;

—the full commitment of responsible officials of the institution to a well-managed project;

—the qualifications of the principal investigator or the program manager;

—availability of the necessary facilities; and

—ability of the proposing institution to provide at least one-third of the project cost.

To review both institutional and project support proposals, the Foundation has established two non-governmental, technical advisory panels. Coordination with other Federal programs has been assured through reviews of the program by the Marine Sciences Council and particularly its Committee on Marine Research, Education, and Facilities.

National Response to the Program

During FY 1968, 78 formal and 87 informal proposals were received. The 78 formal proposals were submitted by 55 institutions in 28 States, with the heaviest concentration of formal proposals in the fields of food from the sea, engineering and ocean engineering, and advisory services. By contrast, very few formal proposals have been received in the fields of minerals and drugs from the sea, law, economics, political science, or recreation.

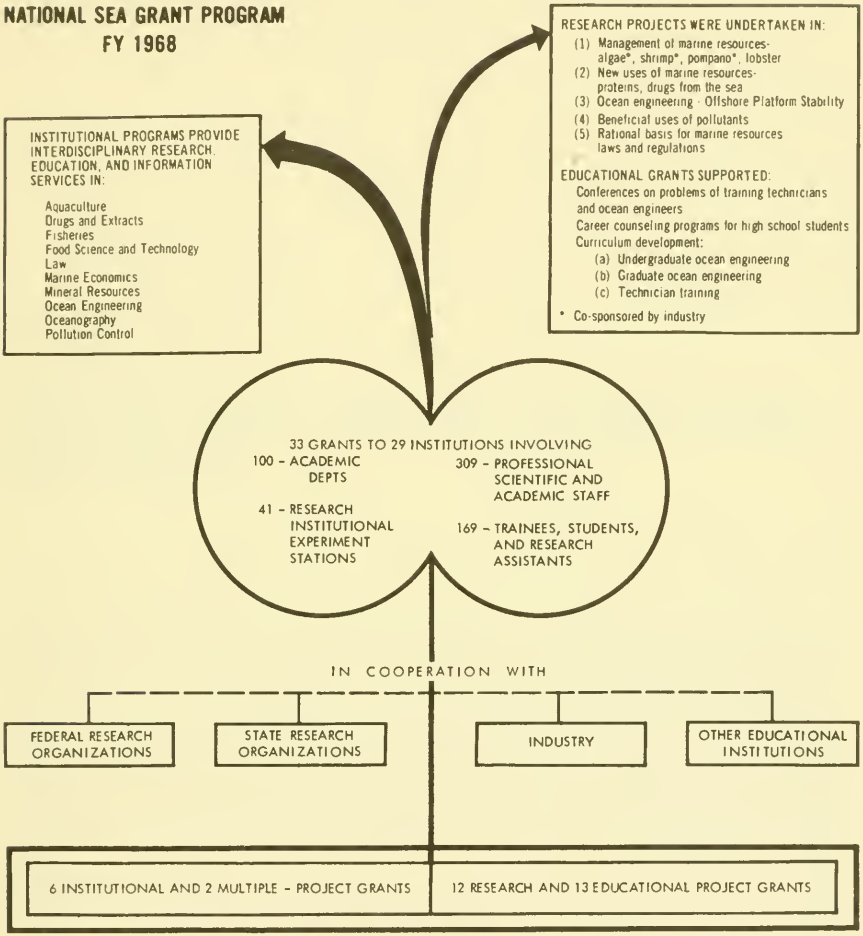
In FY 1968, total funding for the Sea Grant Program amounted to $5 million, which supported 27 Project Grants, and Institutional Grants at Oregon State University, University of Rhode Island, University of Washington, University of Hawaii, Texas A&M University, and University of Wisconsin (Figure X–1).

The Marine Sciences Council advises the Foundation with respect to Sea Grant policies, procedures, and operations. The Council thus reviewed and endorsed plans for strengthening Sea Grant programs in FY 1970 at a higher level of budgetary support than in previous years as shown in Table X–1.

Table X–1—Sea Grant Funding Levels

	Total	Institutional support	Project support
FY 1968:			
Research	$3,007,200	$1,665,900	$1,341,300
Education and training	1,610,000	500,000	1,110,000
Advisory services	382,700	379,700	3,000
Total, FY 1968	4,999,900	2,545,600	2,454,300
FY 1969:			
Research	3,500,000	2,600,000	900,000
Education and training	2,000,000	1,220,000	780,000
Advisory services	500,000	480,000	20,000
Total, FY 1969	6,000,000	4,300,000	1,700,000
FY 1970:			
Research	6,100,000	3,900,000	2,200,000
Education and training	2,500,000	2,100,000	400,000
Advisory services	1,400,000	1,200,000	200,000
Total, FY 1970	10,000,000	7,200,000	2,800,000

Figure X–1—Institutional and Project Sea Grants



Source: National Science Foundation.

"The direction of building is North."—VILHJALMUR STEFANSSON

Chapter XI

FORMULATING ARCTIC POLICIES AND PROGRAMS

Awareness of the great economic potential and strategic importance of the Arctic is rapidly increasing in the United States and other countries bordering that region. While the Arctic region,[1] especially the land area, has been reconnoitered sufficiently to identify its importance, further development and exploitation of this area will depend in large measure on an explicit determination to devote more attention and resources in our Arctic programs. In view of the large marine portion of the Arctic, the Marine Sciences Council undertook a reappraisal of U.S. Arctic policy as it relates to marine activities.

The Arctic is the "last frontier" in the northern hemisphere in terms of the world's limited natural resources and space for an expanding world population. In spite of the extremely adverse climate, modern technology—

[1] The Arctic region is here defined as the land area surrounding the North Pole, to the southern limit of continuous permafrost, and the Arctic Ocean and adjacent waters. The U.S. Arctic, or Arctic Alaska, is defined as that land and Continental Shelf north and west of the Yukon River. The Arctic region, some 8.3 million square miles, centers on the Arctic Ocean and includes almost 3 million square miles of continuous permafrost land. The Arctic Ocean itself covers 5.4 million square miles, an area 50 percent larger than the United States, and connects the Atlantic and Pacific Oceans. A perennial, floating icepack extends from the North Pole to the edges of the Ocean. The mean monthly temperatures for this region range from minus 40° F. to plus 50° F.

clothing, shelter, transportation systems, and operational techniques—makes possible year-round human occupancy and work.

The Arctic region, consisting largely of international areas subject to the high seas regime affording freedom of transit, is important to the development of the United States and the North American continent. It affords the shortest distance between the continents of Eurasia and North America. The Arctic Ocean may take on increased significance as the technologies of underice, icepack, and aerospace operations are more fully developed and as the economic potential of the Arctic littoral is realized.

Oil and gas of the Arctic can help meet U.S. strategic requirements if energy reserves from foreign sources are cut off in times of emergency. An alternate supply of petroleum could also ease the dependence of our major allies on Mideast and African oil. While the plentiful strategic and precious metals in the Arctic are not being intensively exploited, they are likely to be in the long term as the world's population expands and other sources are depleted. Also, economic development of Arctic resources may be a promising way to improve urgent social and economic problems of the indigenous population of Alaska.

Scientific observations in the Arctic are of key importance because that region critically influences global weather patterns and ocean circulation, permafrost and sea ice properties, upper atmospheric phenomena, and ultimately all marine and terrestrial ecosystems. In addition, archaeological, social, and anthropological investigations of native populations would be of great scientific interest.

Internationally, the Arctic Ocean makes us neighbors to four other nations—U.S.S.R., Norway, Denmark, and Canada. Although Finland, Sweden, and Iceland do not abut the Arctic Ocean, they too share our concern over exploration, development, settlement, and exploitation of the Arctic region. Japan has shown increased interest in Arctic resources as manifested by investment and commerce, primarily with Alaska and Canada, in far northern resources such as timber and oil. The environmental hazards, high costs, and limited U.S. expertise make international cooperation in Arctic exploration very attractive.

Developing an Arctic Policy

The Marine Sciences Council developed and endorsed the following statements as a point of departure in considering a national Arctic policy, which must be developed on a broader basis than only marine sciences, and in considering mechanisms for carrying forth such a national policy.

It should be the objective of the United States to achieve the following:

1. A leading U.S. position in the Arctic that will satisfy its political, scientific, economic, and other interests.
2. The economic development of Alaska including its Continental Shelf to:
   a. Increase the availability of its natural resources.
   b. Encourage the growth of private investment.
   c. Minimize inflationary effects on the Alaskan economy.
   d. Maximize the opportunities for development for the population of Alaska.
   e. Minimize disturbances of the ecology of the region and ensure consideration of the conservation of its resources.
3. An intermodal transportation system to enhance the growth and support of our scientific, economic, and other activities in the area.
4. An improved capability to inhabit and operate in the Arctic.
5. Mutually beneficial cooperation with our Arctic neighbors and other nations in exploration, exploitation and scientific studies.
6. Free exchange among all nations of technical and economic data regarding the Arctic.
7. A fuller understanding of the marine and terrestrial Arctic environment through broad programs of scientific research.
8. In conjunction with other economic, social, and political objectives, assure a capability to perform those operations necessary to the successful conduct of national defense.

Federal agencies having responsibilities for Arctic affairs should, subject to coordination as appropriate by the Secretary of State, initiate actions as follows:

1. Provide or utilize appropriate mechanisms within the Executive Branch for national policy planning, review, and coordination of Arctic activities.[2]
2. Conduct the necessary research and engineering development to operate effectively in the Arctic, including such activities as:
   a. Development of environmental sciences to promote the safe and effective use of the physical environment.
   b. Development of materials and designs for structures, vehicles, platforms and systems capable of supporting safe operations on land and on, under and within the icepack.
   c. Studies of the ecological implications of proposed undertakings.
   d. Development of adequate power sources for operation in the Arctic.
3. Advance and improve the health, nutritional and educational standards of the native citizens.

[2] Among the organizations which currently are planning and coordinating Arctic activities are the Federal Field Committee for Development Planning in the Arctic, the Council's Committee on Marine Research, Education and Facilities, and the Interagency Arctic Research Coordinating Committee.

4. Enhance the education and training of technical and professional personnel for Arctic work.

5. Evaluate the impact of individual agency programs in Alaska in terms of the ability of the Alaskan economy to handle the aggregate impact of these programs without harmful inflation.

6. Accelerate the development of a comprehensive understanding of the mineral and biological resources of the Arctic region and of associated technical, economic and social problems.

7. Encourage, support, and conduct broad fundamental research programs to develop a fuller understanding of the Arctic environment.

8. Investigate the feasibility of developing an intermodal transportation system for the Arctic through public and private investment which will:
   a. Provide access to all Arctic areas.
   b. Provide a system capable of transporting passengers and cargoes.
   c. Extend the shipping season to and from Arctic Alaska and the Arctic region.

9. Promote international cooperation in exploration, research, safety, health and welfare and other activities which will be beneficial to all countries.

Expanding Arctic Research Capabilities

Eleven Federal departments and agencies with a total FY 1968 budget of more than $20 million (Table XI–1) involving some 600 to 700 people, including scientists and technicians, are engaged in programs of Arctic science, resource development, health and welfare, and military research and development. U.S. research programs represent a broad spectrum of disciplines including oceanography, glaciology, earth sciences, meteorological and ionospheric sciences, and the biological sciences. Technical activities include surveying and mapping, natural resource inventories, weather observations, ice observations from ships and aircraft and eventually from satellites, reclamation, transport, and construction.

Eleven Federal and federally supported facilities serve as centers for most of this work.

In 1967 and 1968 the development of capabilities to conduct oceanographic research in polar and subpolar areas was selected by the Council as an area deserving priority attention. Last year the Council recommended that a replacement Coast Guard ship authorized for the International Ice Patrol be especially designed and equipped so that oceanographic research in the high latitudes could be expanded. This ship, depicted in Figure XI–1, is scheduled for commissioning in 1970. Complementing this new

Table XI–1—Federal Funding for Arctic Research and Development, FY 1968

(In thousands of dollars)

	Total research	Marine sciences	Logistics supporting marine sciences
Department of Army	919	.....	.....
Department of Navy	2,075	(2,075)	1,966
Department of Air Force	1,574	.....	.....
Department of Transportation	63	(63)	6,237
Department of Commerce	681	.....	74
Department of Agriculture	380	.....	.....
Department of HEW	1,896	.....	.....
Department of Interior	1,171	(823)	.....
National Science Foundation	2,216	(612)	.....
National Aeronautics and Space Administration	1,467	.....	.....
Atomic Energy Commission	201	.....	.....
Total	12,643	(3,573)	8,277

Source: Interagency Arctic Research Coordinating Committee.

Figure XI–1—*The new Coast Guard oceanographic research ship WHEO 701 has been specially designed for research activities in the high latitudes in addition to its duties for the International Ice Patrol.*

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capability for research in subpolar areas has been the completion of a preliminary design for a medium class polar ice breaker with a significantly greater capability than ice breakers currently operating in the U.S. fleet. Alternative designs have been model-tested and design parameters have been computerized for analyzing tradeoffs. Also, ice breakers currently in service have been instrumented to develop additional data. Meanwhile, the facilities for the Navy Arctic Research Laboratory at Barrow, Alaska, have been expanded (Figure XI–2).

A Framework for Scientific Activities

To provide a more coherent framework for these activities the Council has stated that scientific objectives of Arctic marine research programs should include a better understanding of:

—the interactions between the atmosphere, ice cover, and ocean waters and the role of these interactions in global atmospheric and oceanic circulation;
—the Arctic Ocean climate and its relation to glaciation of the continents;
—the geological character and structure of the Arctic region and its role in the evolution of the continents and their shelves;
—the formation and modification of Arctic coastal and submerged features;
—the character and distribution of the biota and its variations;
—the ecosystems of the Arctic, their productivity, and the impact of human activity;
—the physical properties and behavior of Arctic ice;
—the physical and chemical characteristics of Arctic water masses and their relation to the global ocean;
—the geographic and temporal variations of polar cap atmospheric and ionospheric events; and
—the acoustical characteristics of the Arctic seas.

Research and exploration will thus continue to undergird our Arctic activities. All considerations require improved understanding of the air, sea, and land environments and the predictability of the dynamic processes of air, ice, and water and their interactions. New knowledge is needed to construct and operate facilities, roads, harbors, and vehicles to open this territory. Engineering studies are needed to gain the know-how and to develop improved technical applications which give man the ability to cope with and use the environment.

Figure XI–2—*The new Arctic Research Laboratory complex of the Office of Naval Research, shown in the foreground, was completed in September 1968 and can accommodate 85 people. This facility, fronting on the Arctic Ocean at Barrow, Alaska, supports research in the biological and physical sciences, including oceanography.*

The search for resources has only begun: geological, geophysical, and geochemical maps necessary to mineral exploration and prospecting have yet to be made; the Continental Shelf area is almost entirely unexplored; Arctic equipment and techniques for mineral extraction need to be developed. Bulk transport systems which can cope with the Arctic environment are needed to carry the products to market. At present there is no deep water port facility in Arctic Alaska. These are but a few of the challenges of the Arctic Basin which face Federal agencies, the State of Alaska, industry, and the scientific and engineering communities.

"The sea never changes and its works, for all the talk of men, are wrapped in mystery." —Joseph Conrad

Chapter XII

UNDERSTANDING AND SURVEYING THE OCEAN ENVIRONMENT

The rate at which we increase the harvest of ocean resources, promote safe maritime navigation, and improve the accuracy of forecasts of environmental conditions affecting activities on both land and at sea is critically dependent on the growth of our efforts to explore, map, and measure the seas. The identification and assessment of ocean resources and features through systematic exploration will also aid in establishing Federal-State development and regulatory policies and provide basic knowledge for consideration of international legal questions related to ocean resources. More accurate, timely, and longer range forecasts of climate and weather conditions, storms, waves, ice, tidal waves, tides, coastal surf and currents, storm surges, floods, and ocean temperatures will benefit national defense and expanding commercial and recreational marine activities; reduce the destruction of life and property in the Coastal Zone and at sea; enhance industry, agriculture, water management, and other land activities affected by weather and nearshore ocean conditions; and contribute to the advancement of science.

Mapping, Charting, and Geodesy

This section deals with those features of the oceans which vary slowly with time so as to permit preparation of maps for understanding and use

of the oceans. The oceans are largely unexplored beyond the gross shape and structure of the sea floor, and maps for science, economic development, and national defense are often inadequate. Needs are multiplying for a wide variety of maps delineating biological stocks, mineral resources, and physical and geophysical characteristics of the sea and seabed. Figures XII–1 and XII–2 describe the current extent of our knowledge of regional geology and living resources close to U.S. shores.

Mapping, charting, and geodesy account for roughly 19 percent of the marine science funding (Table XII–1). Over 30 ships in the Federal oceanographic fleet are engaged in ocean surveying activities. A number of agencies conduct mission oriented surveys, with ESSA and Navy supporting most of the effort and providing most of the widely used general purpose maps. The objectives of ESSA's Continental Shelf mapping program are briefly described in Chapter VII and Navy activities are summarized in Chapter V. Additionally, ESSA conducts a deep sea mapping program (SEAMAP) intended to provide 1:1,000,000 scale bathymetric and geophysical mapping of 30 percent of the world's deep oceans for economic and scientific purposes. Another long-range goal is development of a capability to permit recharting of all U.S. coastal waters on a 50-year cycle.

Figure XII–1—Status of Knowledge of Regional Offshore Geology

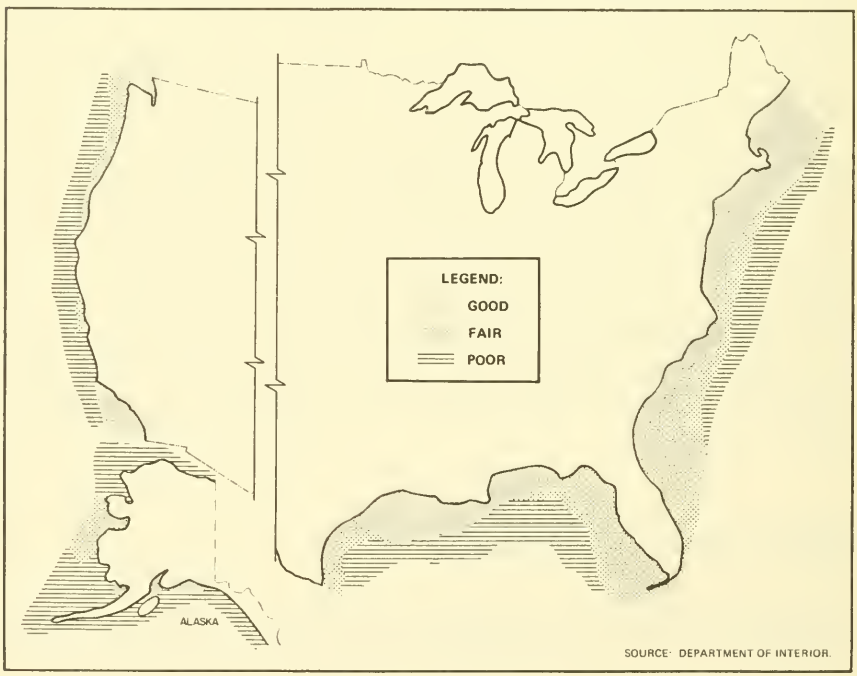

Figure XII–2—Status of Knowledge of Living Resources of the Continental Margin

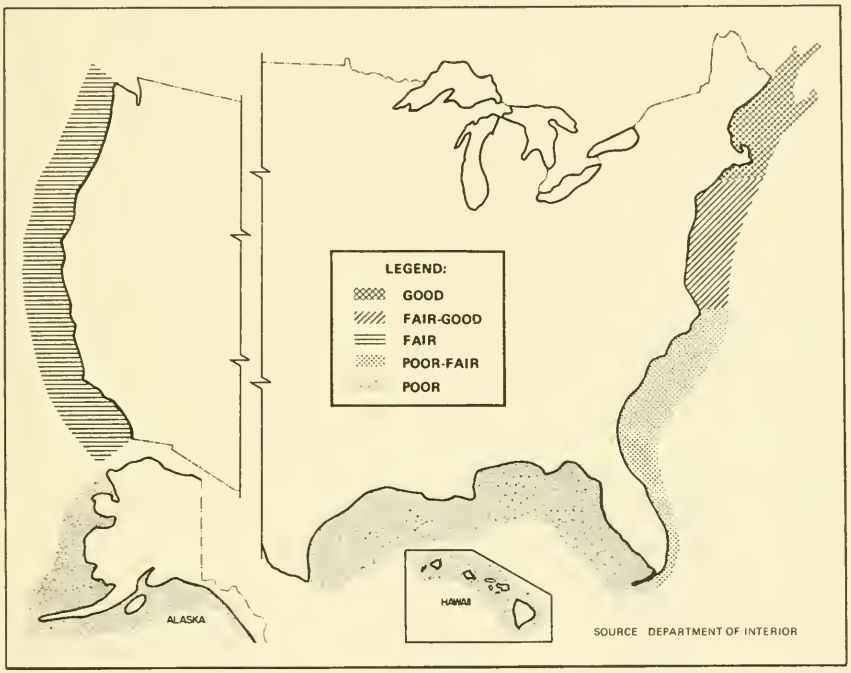

Table XII–1—Funding for Mapping, Charting, and Geodesy

(In millions of dollars)

Agency	Estimated fiscal year 1968	Estimated fiscal year 1969	President's budget fiscal year 1970
Department of Defense	58. 6	63. 5	78. 5
Navy	(57. 9)	(62. 7)	(77. 7)
Corps of Engineers[a]	(0. 8)	(0. 8)	(0. 8)
Department of Commerce	16. 8	19. 1	20. 2
NASA	0. 3	0. 4	0. 4
Total	75. 7	83. 0	99. 1

[a] Charting of the Great Lakes.

The worldwide deployment of the U.S. oceanographic fleet engaged in a variety of research and exploration activities on October 3, 1968, is illustrated in Figure XII–3.

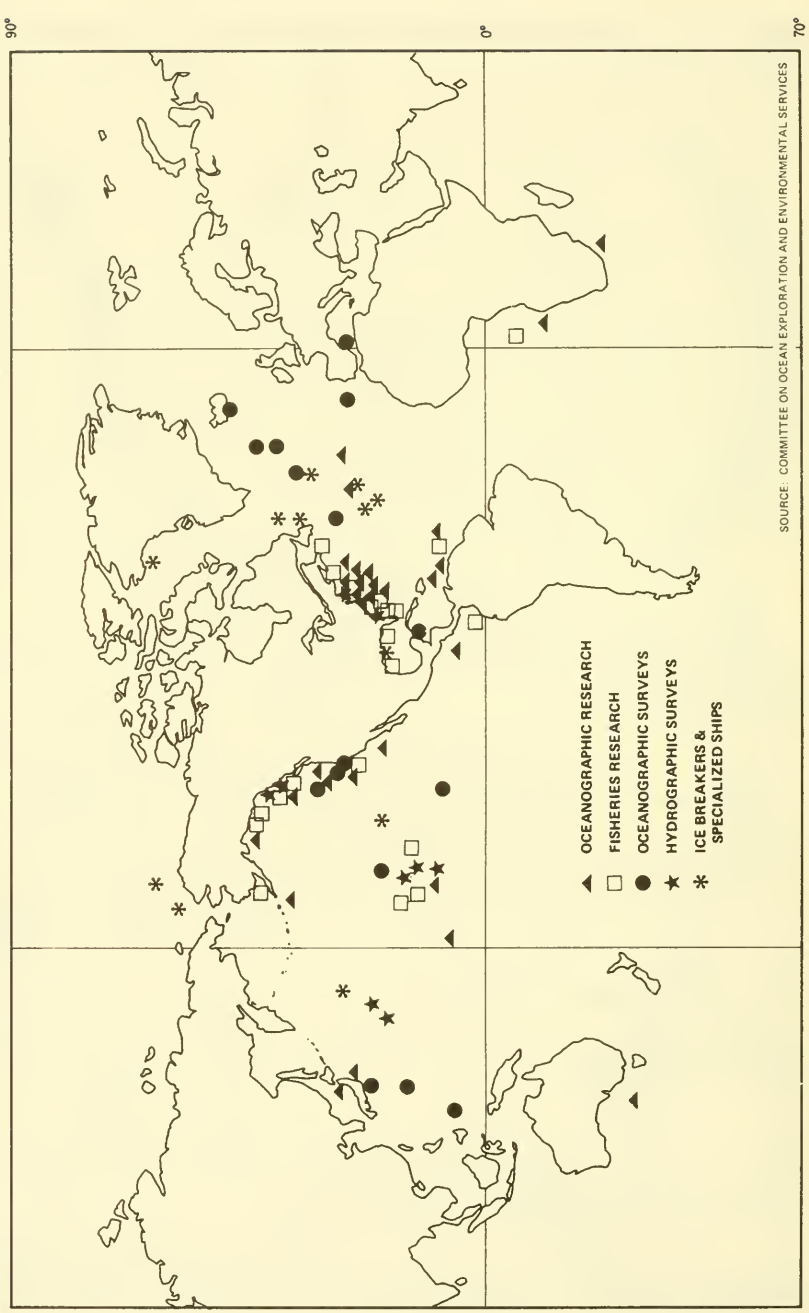

Figure XII-3—Deployment of U.S. Oceanographic Fleet, October 3, 1968

Among the 1968 highlights of Federal programs in mapping, charting, and geodesy in addition to those noted in Chapter V were:

—initiation of bathymetric, gravity, and magnetic surveys in the Norton Sound area off Alaska (ESSA);

—completion of a continuous geophysical profile across the South Pacific (lat. 35° S.) which revealed previously unknown submarine volcanoes and mountain ranges (ESSA);

—identification of two fracture zones and a major sea channel discovered in the Aleutian abyssal plain (ESSA);

—completion of hydrographic surveys off Vietnam, Guam, and the Mariannas, and in Subic Bay, Philippines (Navy);

—preparation of experimental photogrammetric maps with closely spaced contour intervals from data obtained by submersibles (Navy);

—development and testing of high speed hydrographic surveying techniques using faster launches and automated data acquisition and positioning equipment (ESSA and Navy);

—investigations of ocean conditions affecting the north polar front between 160° and 180° west longitude (ESSA); and

—initial survey of the Weddell Sea to classify the flow of Antarctic waters (Coast Guard).

Ocean Observation and Prediction

About 6 percent of the Federal effort in marine sciences is devoted to observations related to understanding and predicting the ocean environment, largely dealing with time-dependent variables. The Navy, ESSA, Coast Guard, NASA, Corps of Engineers, and Atomic Energy Commission fund the activities as shown in Table XII–2, with the programs of the Bureau of Commercial Fisheries described in Chapter VI.

A broad range of marine forecasting services for defense forces has been developed by the Navy in response to worldwide military security requirements. These include:

—sea surface and water column temperature, salinity, and sound velocity prediction for anti-submarine warfare;

—sea ice observations and forecasting for fleet operations and seaborne logistics;

—sea state prediction for fleet operations and spacecraft recovery at sea and for Coast Guard activities on the Great Lakes;

—nearshore environmental prediction, including beach breaker and surf forecasts, for mine warfare and amphibious operations; and

—high seas and coastal marine weather forecasts to support fleet operations.

Table XII–2.—Funding for Ocean Observation and Prediction

(In millions of dollars)

Agency	Estimated fiscal year 1968	Estimated fiscal year 1969	President's budget fiscal year 1970
Department of Defense	10. 5	11. 6	11. 5
Navy	(10. 2)	(11. 3)	(11. 2)
Corps of Engineers	(0. 3)	(0. 3)	(0. 3)
Department of Commerce (ESSA)	6. 2	5. 8	6. 0
Department of Transportation (Coast Guard)	9. 7	12. 0	12. 7
NASA	1. 5	1. 4	1. 3
Atomic Energy Commission	0. 9	0. 8	0. 6
Total	28. 8	31. 6	32. 1

Environmental prediction services operated by ESSA for civilian use include:

—high seas, coastal, and Great Lakes marine weather forecasts;
—tropical storm, hurricane, and storm surge warnings and forecasts;
—tide and tidal predictions from a network of 122 stations along the coast and within major embayments;
—publication of charts showing tidal current patterns for each hour of the cycle in major U.S. harbors and estuaries;
—breaker and surf forecasts for the beaches of southern California; and
—tsunami warnings.

Specific achievements in 1968 included:

—establishment of VHF–FM radio stations in Norfolk, Atlantic City, and Tampa to provide coastal weather broadcasts (ESSA);
—activities of computer-produced 24- and 48-hour sea state predictions for the North Atlantic and North Pacific (ESSA);
—establishment of a pilot estuarine flushing and non-tidal current prediction service for the Penobscot Bay (ESSA);
—development of computer-produced charts for tsunami arrival times in the Pacific (ESSA);
—completion of a *Federal Plan for Marine Meteorological Services* (Commerce);
—initial forecasts of wave heights four times daily in the Great Lakes (ESSA);
—testing of a numerical hydrodynamical model for water level and current predictions in harbors (Navy);
—development of a "live atlas"—new data formats and application of computer technology—which reduces time for scanning North Atlantic oceanographic stations from 9 hours to 11 minutes (Navy);

—improvement in ocean prediction services, including broader use of fleet ships for data collection, refinement of sound propagation models, and expanded use of air-dropped expendable sensors (Navy); and

—continuous measurement of inshore wave action at 23 stations on the U.S. coast to assist coastal engineering activities (Corps of Engineers).

Also, the Joint Chiefs of Staff established a Special Assistant for Environmental Services to improve coordination of Defense Department environmental activities, including marine activities.

Development of Buoy Technology

Preliminary studies have indicated that oceanographic buoys appear to be a cost-effective means for acquiring synoptic data on ocean and atmospheric conditions needed to achieve major gains in environmental forecasting.[1] Therefore, in 1967 the Council recommended that the Coast Guard be assigned lead-agency responsibility for further research, development, testing, and evaluation to advance data buoy technology and determine system requirements preparatory to a future decision on establishing a National Data Buoy System.

During 1968, the Coast Guard intensified its efforts to refine user requirements for marine environmental information, to study the dynamics of the marine phenomena to be measured, to analyze the role of data buoys in relation to other data collection systems, to develop needed analytical tools, to develop a satellite data relay capability, and to study the management of high frequency communication channels assigned for transmission of oceanographic data. The broad approach endorsed by the Council to be carried forward in FY 1970 is designed to lead to the procurement and development of a prototype system of 35 unmanned telemetering buoys

[1] A recent major study, funded jointly by Federal agencies, concluded that systems of data buoys with wide geographical coverage are technically feasible and the most cost-effective means of satisfying a large number of government-wide operational and research requirements for marine meteorological and oceanographic data. The study analyzed and categorized four sets of requirements for marine data: (a) global (deep ocean, large scale—300 to 500 mile grid); (b) coastal North America (medium scale—50 to 200 mile grid); (c) Great Lakes and estuaries (territorial U.S. waters, small scale—10 to 50 mile grid); and (d) research requirements (all areas, various scales from large to very small scale grid). The study showed that a substantial saving is possible if buoy systems are designed and operated to serve national requirements for data acquisition as opposed to single agency requirements.

moored in deep water, a shore based communication capability, a vessel modified to service the buoys, and the necessary shore support by FY 1974. The development and deployment of this limited pilot system should provide additional experience on which to base decisions on the extent and timing of implementation of follow-on operational systems. Specifically, $9.8 million requested for FY 1970 is intended for:

—state-of-the-art investigations of buoy technology ($4.5 million);
—concept formulation for a prototype deep ocean/coastal system ($4 million);
—exploratory development of sensors and alternative approaches to high risk components ($0.8 million); and
—systems management and support ($0.5 million).

Additional related activities include commencement of the first experiment using "monster" and other buoys [2] to study the mechanisms of formation and progression of large persistent thermal anomalies which develop in the surface waters of the North Pacific and progress across the ocean. Also, the test of the Coast Survey Marine Observation System (COSMOS) was completed successfully by recovering the platform in excellent condition after its second year on station in 5,000 feet of water 100 miles off Los Angeles.[3]

Advancing Spacecraft Oceanography

Last year the Council requested NASA to assume lead agency responsibility for coordination of sensor technology, techniques for space oceanography, and testing of new developments. Recently NASA established the Earth Resources Survey Program Review Committee (ERSPRC) to provide a formal inter-agency mechanism for (a) reviewing and analyzing the total earth resources program including spacecraft oceanography, (b) providing advice and recommendations to NASA on both the current and future responsiveness of the NASA research and development program to user agency requirements, and (c) providing advice and recommendations to user agencies to achieve maximum integration of requirements and cor-

[2] The initial experiment requires mooring two "monster" buoys (12.2 meter diameter) and eight smaller, catamaran-type "bumblebee" buoys (4.9 by 2.5 meters) in the central North Pacific for several years.

[3] The COSMOS platform on which various instrument capsules can be mounted is normally moored about 100 feet below the sea surface by three steel cables anchored to the bottom at 45°. The catenary is reduced by attaching glass spheres along the cable at close intervals, thereby substantially lessening the vertical mobility of the positively buoyant platform.

relation of effort. This Committee thus assists NASA and the Council in coordinating spacecraft oceanography activities.

Among the 1968 results in developing techniques for observations from both spacecraft and aircraft sponsored by NASA, Navy, and ESSA were:

—improvements in automated processing of NIMBUS infrared data for mapping sea surface temperature gradients and positions of current boundaries, meanders, and eddies in the North Atlantic Ocean;

—enhancement of color photography obtained by aircraft, Apollo 501, Apollo 502, and Gemini flights showing the high correlation between nearshore ocean depth contours and film density gradients;

—analysis of data obtained during hurricane BEULAH in the Gulf of Mexico confirming previous experimental results linking the presence of sea foam with a marked increase in thermal radiometric response;

—demonstration of infrared radiometry techniques to locate from aircraft strong thermal gradients that are frequently indicative of fish feeding areas;

—initiation of work to relate sea surface temperatures obtained from radiometric data and those obtained from *in situ* measurements;

—improvements in computer processing of sea ice imagery and development of infrared techniques for sea ice mapping; and

—initial use of ruby lasers on Navy aircraft for imaging sea ice topographic profiles and use of neon-helium lasers to profile ocean surface waves.[4]

Figure XII–4 shows one of a set of photographs of particular interest to the marine science community obtained from the Apollo 7 flight on October 15, 1968.

Planning Ahead

In recognition of the growing importance of programs to observe and predict oceanic conditions, the Council endorsed the preliminary draft of a 5-year Federal Plan for Marine Environmental Prediction (MAREP)

[4] Council contract, "The Potential of Observation of the Oceans from Spacecraft," evaluates the future potential of satellities for ocean observations. The study report projects the technological state-of-the-art for observation of sea surface temperature, sea ice, and wave height for the next 5 years, analyzes requirements and related costs and describes benefits that could be achieved. The Council report, "United States Activities in Spacecraft Oceanography," prepared by NASA and the Naval Oceanographic Office, assisted by other interested agencies, presents information about the potential of satellite observation to assist scientists and engineers in planning for possible participation in future programs.

Figure XII–4—*As seen by the crew of Apollo 7 on October 15, 1968, the waters around the islands of Socotra and The Brothers, caught in the sun's reflection, reveal complex surface phenomenon impossible to obtain by ordinary means. Situated just off the east African coast and north of one of the strongest upwelling areas in the world, the islands form a deflective barrier to the northeastward movement of the cold, upwelled water. The vortices, slicks, swells, and other lines which are visible reveal current direction, internal waves, and regions of convergence and divergence. Such information is invaluable in understanding the oceanography of one of the world's largest undeveloped fishing regions.*

prepared by its Committee on Ocean Exploration and Environmental Services. This plan is currently being refined and should serve as guidance to agencies for the development of future Federal programs related to ocean observation and prediction. The plan identifies ongoing projects, present and future requirements, and programs for strengthening and expanding current activities. It is also expected to present the needs, benefits, program rationale and strategy, implementation targets, and specific projects in five categories:

program planning and coordination, system design, early implementation, new technology development and implementation, and theoretical oceanographic and applied research.

It is anticipated that the plan will be publicly released when completed to encourage broader understanding and discussion of our national efforts in these fields. MAREP planning is continuing under a small, interagency planning group established by the Council to strengthen development of the initial plan, to commence overall system analyses and design of a composite Federal program for marine environmental prediction, and to assist with technical matters related to planning U.S. participation in the Integrated Global Ocean Station System.[5]

The Council's Committee on Ocean Exploration and Environmental Services is also preparing a Ten-Year Plan for Ocean Exploration (TYPOE) that is expected to provide a framework for considering national needs for and benefits from ocean exploration, goals, and priorities. Also, it should provide guidance in developing Federal programs and determining when exploration should be conducted, by whom, and with what milestones. When completed, TYPOE should be a significant contribution in developing plans for U.S. participation in the International Decade of Ocean Exploration. At that time, TYPOE activities will be integrated with the planning for the Decade described in Chapter IX.

[5] The Fifth Session of the Intergovernmental Oceanographic Commission in October 1967 endorsed development of IGOSS, with platforms such as ships, buoys, satellites, coastal towers, etc., to provide environmental data from ocean areas to all countries in a form convenient for use. Two phases are being planned: Phase I (1968–71 approximately) will use existing technology. Phase II (from about 1971) will increasingly incorporate modern developments, especially moored ocean buoys IGOSS is to be planned and operated closely with the World Weather Watch.

"Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it." —SAMUEL JOHNSON

Chapter XIII

INFORMATION MANAGEMENT

Information responsive to the diverse needs of scientists, engineers, and program planners is critical to the success of ocean-oriented activities. Several types of information are needed:

—environmental data concerning the nature of the oceans and the interactions of man's activities with the marine environment (real-time and archival data including biological, geological, and chemical specimens);

—bibliographic and documentary information;

—program management and budget information about past, present, and projected research activities; and

—statistical, economic, and demographic information concerning man's activities that impinge on or are affected by the marine environment.

Information requirements as well as data collection and distribution are common to numerous Federal and non-Federal organizations. Producers and users of data now include more than 30 bureaus in 15 Federal departments; 30 coastal and Great Lakes State governments concerned with developing and regulating the use of marine resources; 250 Federal, State, academic, and private laboratories involved in marine research; 1,100 merchant ships; 100,000 commercial fishermen; several million sport fishermen; tens of thousands of marine data users in oil and other industrial firms; tens of millions of recreational swimmers and boaters in the coastal and Great Lakes States; hundreds of thousands of Navy and Coast Guard men in our fleets; and more than 7,000 scientists, engineers, specialists, technicians, and others engaged in marine research and development activities. Thus, the Marine

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Sciences Council has during the past two years given high priority to improving government-wide capabilities for handling all types of maritime information produced by an expanding national program to meet the specialized needs of a wide variety of users.

Environmental Data Labyrinth

Collecting, processing, and distributing marine environmental data are functions currently performed within a complex, loosely structured framework which has evolved over time in response to a variety of separate and sometimes unique requirements. While the collection and use of environmental data previously involved a small number of research scientists, intensified interest and activity in the oceans now demands more complete, accurate, and timely data for science, economic development, defense, and other interests.

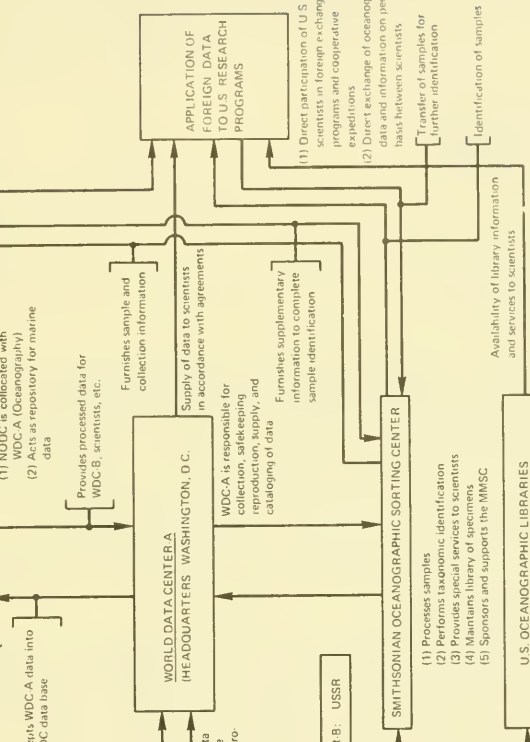
The modes of data transfer are almost as numerous as the uses of the data. For example: ocean scientists may obtain data directly from colleagues to supplement data collected personally or acquired from scientific journals or centralized data banks; government agencies design their data systems to respond to specific agency missions, utilizing, with increasing frequency, highly automated processing facilities as a central link; industrial organizations are developing selective information dissemination techniques to serve individual employees and units while exercising tight control over public release of proprietary data about ocean resource distribution; and the general public turns to maps and bulletins concerning nearshore weather conditions.

The "data problem" and associated costs thus become more serious as data traffic increases, more variables are measured and must be inter-related faster, and the data commodity must be shared with a broader, more diversified clientele. Additionally, international exchange of data is becoming more important (Figure XIII–1).

Environmental Data Repositories of Federal Agencies

Several Federal agencies maintain data repositories. Table XIII–1 shows funding for four of the larger centers; Table XIII–2 indicates the extent of some of these data files.

Figure XIII-1—Flow of Selected Foreign Data to U.S. Scientists



1/ FOR MORE COMPREHENSIVE LISTING SEE TABLE E-1, MARINE SCIENCE AFFAIRS, MARCH, 1968.

NOTE
PRINCIPAL DIRECTION OF DATA FLOW FROM FOREIGN SOURCES IS INDICATED BY THE FLOW LINES AND ARROWS NOT INDICATED HERE IN THE FLOW OF DATA IN THE REVERSE DIRECTION FROM DATA CENTERS TO FOREIGN USERS

Table XIII-1—Funding for Marine Data Centers

Activity	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
National Oceanographic Data Center	1.6	1.7	2.5
National Weather Records Center [a]	(b)	0.1	0.1
Great Lakes Data Center	0.2	0.2	0.2
Smithsonian Oceanographic Sorting Center	0.3	0.3	0.4
Total	2.1	2.3	3.2

[a] Supplemented by funds transferred from other agencies for reimburseble projects.
[b] Less than $50,000.

The National Oceanographic Data Center (NODC), a facility established in 1960 to serve inter-agency needs, is under the administrative management of the Navy. Policy and technical review are provided by an advisory board with representation from each of the ten Federal funding agencies and the National Academy of Sciences. NODC is collocated with World Data Center A for Oceanography and receives, compiles, processes, and stores oceanographic data from both foreign and domestic sources and disseminates these data to U.S. and foreign organizations and institutions engaged in marine science activities.

Some specific accomplishments during the past year were:

—continued procurement of advanced computer capability, including a high-speed automatic plotter, a digitizer (analog to digital), an aperture card camera, and equipment for converting digital data from source documents directly to magnetic tapes;

—initiation of the National Marine Data Inventory (NAMDI), compiling detailed information from 600 cruises of U.S. research and survey vessels in 1967 with the information converted to computer-compatible form;

—significant reduction in the backlog of unprocessed data;

—establishment of NODC liaison offices at Woods Hole and Scripps Oceanographic Institutions; and

—response to 2,200 information/data requests, an increase over 1967 of 35 percent.

Based on Council evaluation and approval, NODC budgets are proposed to increase from $1.7 million in FY 1969 to $2.5 million in FY 1970. Planned activities for FY 1970 include continued development of computer programs and software to be more responsive to requests for services; techniques for handling large volumes of data from expendable bathythermographs, salinity-temperature-depth recorders, manned and unmanned buoys, and satellites; and new data bases, including those for subsurface currents, sea ice, bottom photographs, and ocean engineering.

Table XIII-2—Selected Marine Data Center Files

National Oceanographic Data Center

Data type	July 1967	July 1969
Bathythermograph:		
Digitized	515, 000	604, 000
Analog	400, 000	500, 000
Expendable Bathythermograph: Digitized		15, 000
Salinity-Temperature-Depth: Analog		3, 000
Oceanographic Station	375, 000	415, 000
Geological	18, 000	[a] 24, 000
Biological	8, 000	[b] 12, 000
Surface Current	2, 500, 000	2, 500, 000

Environmental Science Services Administration

Data type	Units	Estimated total holdings	Estimated annual accumulation
Tides	Station-years	3, 000	180
Currents	Stations		100
Soundings and Shoreline Surveys.	Survey sheets	35, 000	2, 500
Fathograms	Linear survey miles	2, 000, 000	150, 000
Geodetic Control [c]	Points	400, 000	1, 250
Aerial Photos [c]	Prints	2, 000, 000	20, 000
Magnetics [c]	Linear survey miles	2, 000, 000	200, 000
Gravity [c]	Linear survey miles		50, 000
Seismic Profiles	Linear survey miles		10, 000

Smithsonian Oceanographic Sorting Center

Data type	Samples received	Specimens sorted	Number of shipments
Algae	4, 970	4, 310	188
Geology	4, 800	562	14
Invertebrates	4, 870	5, 710, 000	251
Plankton	17, 100	11, 400, 000	239
Vertebrates	3, 850	657, 000	494

[a] Unprocessed backlog—81,000.
[b] Unprocessed backlog—40,000.
[c] Figures represent only marine data holdings and not total ESSA holdings.

The primary Department of Defense marine data repositories include the Nautical Chart, Bathymetry, Gravity, and Geomagnetics Library and the Fleet Numerical Weather Center. Automated source index systems have been recently installed in all of these facilities and automated plotters to

portray computer-generated information graphically are now operational. Consideration is being given to storing all bathymetric and geomagnetic data in digitized form and, as automated data processing systems are installed on all Navy survey ships, data reduction to digitized form can keep pace with data collection. Other Defense Department facilities are responsible for gravity and geodetic data, and rapidly expanding automated data processing capabilities will eliminate existing backlogs of unprocessed data by FY 1971. The Navy's Fleet Numerical Weather Center at Monterey, California, is the hub of the Naval Environmental Data Network and the center for an environmental forecasting program which covers most of the Northern Hemisphere. The broad range of forecasts provided by this center is used by a wide variety of military and civilian organizations. For rapid data exchange, a data link is being established between NODC and Monterey.

The Great Lakes Data Center, operating under the Corps of Engineers, has a program directed toward processing, storage, retrieval, and dissemination of:

—hydraulic and hydrologic data (water level);
—oceanographic data (physical, chemical, and biological);
—hydrometeorological data (precipitation); and
—hydrographic data (depth).

Data provided by the Great Lakes Center assist in regulating the levels and overflow of Lakes Superior and Ontario and the flow over Niagara Falls and determining the division of water for hydroelectric power between the United States and Canada. Such data are also used extensively in research on fisheries, pollution, shore processes, currents, and ice formation and movement. During FY 1970 services of the Center, augmented by additional automatic data processing equipment, will provide new monthly publications of water temperature data.

The ESSA National Weather Records Center is the major repository for marine meteorological data, including sea surface temperature and ocean wave data. The observations are forwarded from 2,100 merchant ships and a much smaller number of fixed stations, such as ocean station vessels and lightships, in accordance with procedures adopted by the World Meteorological Organization and provide a broad basis for climatological analysis. Satellite photographs and nephanalyses also are included in the data file. Several new publications are planned by the Center, including a *Series of Atlases for U.S. Coastal Waters* out to 250 miles offshore in support of intensified activities on our Continental Shelf; *Climatological Summaries for U.S. Lightships* to assist vessels approaching lightships; *Climatological Summaries for Ocean Station Vessels;* and a *Historical Sea-Surface Temperature Project* in support of fisheries research and studies of air-sea interaction. Equipment acquired in 1968 now permits experimental automation of most stages of data-handling processes from acquisition of raw data aboard ship to final graphics.

Environmental data management efforts of the Department of the Interior relate to (a) the statistical reporting system of the Bureau of Commercial Fisheries, including collection, compilation, and publication of data on the volume of catch by species, area of capture, type of gear and craft used, and number of fishermen involved (Chapter VI), (b) the data collection and analysis activities of the Geological Survey, and (c) the storage and retrieval system of the Federal Water Pollution Control Administration, originally designed to automate water quality data produced by Federal, State, and local monitoring programs and subsequently expanded to include project and other management information.

The Smithsonian Oceanographic Sorting Center processes biological and geological specimens for scientists throughout the world. The Center receives samples of marine algae, plankton, invertebrates, and vertebrates from oceanographic expeditions and biological field stations, sorts the samples into taxonomic groups, and forwards them to researchers in the United States and abroad. During the past year a petrographic laboratory was established, and a new automatic data processing and retrieval system was successfully tested. Also, the Smithsonian Institution continued to operate its Mediterranean Marine Sorting Center in Tunisia with specialists in France, Italy, Malta, Rumania, Yugoslavia, and the host country contributing samples.

The data management program of the Coast Guard includes collection and reduction of data acquired from research vessels, ice breakers, and ocean stations; collection and transmittal of ice observations and related predictions to International Ice Patrol headquarters; analyzing and filing data from automated data collection systems; and planning for data aspects of the National Data Buoy System.

New Steps To Strengthen Information Management

A number of characteristics of our current information practices retard effective flow of data from producer to user:

—inconsistent practices among producer groups in taking oceanographic measurements and presenting data, and by users in identifying requirements and criteria for accepting and rejecting data;

—lack of awareness of many potential users of information sources, in view of the multiplicity and diversity of Federal, State, industry, and university organizations; and

—lack of automated data-handling facilities and compatible measuring instruments.

Additionally, the nature of marine endeavors complicates data management problems due to:

—the large geographic and vertical domain of the marine environment from which data must be collected;
—difficulty of installing and maintaining data collection platforms and instruments in the ocean;
—difficulty in transmitting data from distant ocean areas to shore-based facilities; and
—availability of new data collection techniques—buoys, satellites, and advanced instrumentation—which increase the volume of useful data but overload the existing data service facilities.

To meet these deficiencies, the Marine Sciences Council, in 1967, initiated a comprehensive data management study on contract, jointly funded by nine agencies. A Data Management Advisory Panel from industry and the scientific and engineering communities as well as Federal agencies was appointed by the Executive Secretary to develop requirements and to monitor the study. The study being conducted by System Development Corporation is now in its second phase and will be completed during the current fiscal year. It will identify and forecast data requirements, delineate a national data program and a transition plan to improve coordination of existing marine data and information service functions, and determine cost estimates for the principal components and alternatives.

The study has surveyed and analyzed nine data user and producer communities: fishing; ocean engineering; research; environmental forecasting; merchant shipping; industrial operations; naval planning and operations; recreation, conservation, and education; and State and regional planning and management. On this basis, the following steps have been completed:

—description of the producer and user communities;
—identification of the purposes for which data are collected and used;
—classification and evaluation of explicit data and identification of priorities;
—determination of the adequacy of existing data products and services and the need for improvements;
—estimation of data acquisition and service costs and user benefits derived from services; and
—delineation of the nature of data flow between diverse producers and users.

The complex problems associated with the flow of marine science data from acquisition to use are being approached by planning for data handling over the next ten years. If not resolved, an intensification of the problems of poor service, slow response time, and excessive costs will continue into the future. The data study should provide the means to determine how data functions and activities should be organized and conducted to achieve the required progress in providing the kinds and quality of services needed by all sectors of the marine science affairs community.

Collecting Management Information

The Council has given explicit recognition to the four kinds of marine data and information mentioned earlier. As a next step, the Council considered the need for accessible, comprehensive, definitive, and fully descriptive information about current research activities in the marine sciences. Program planners and managers in all sectors—Federal, State, academic, and private—require this information to identify gaps in research and development and to prevent inadvertent duplication of effort. Research proposal evaluation teams need to know how an intended project relates to others in the same area. For the individual scientist, rapid and comprehensive access to background information about ongoing activities can stimulate the selection and orientation of new projects.

To strengthen this element of information management, the Council requested the Science Information Exchange (SIE) to undertake continuous collection and dissemination of information about current unclassified research activities in the marine sciences as part of its primary mission. All Federal agencies and 350 non-Federal organizations with marine science programs were asked to review procedures for promptly submitting summaries of current projects to SIE. Also SIE was awarded a Council contract to prepare a catalog of about 2,500 current marine science projects to be released in the near future.

Meanwhile, the Council staff continued its role as the focal point for collecting and analyzing program and budget data concerning Federal research programs and for gathering data on the total national effort. These activities are reflected in the budget tables presented throughout this Report. Also, the individual agencies, Council staff, and Council Committees have expanded efforts to collect and analyze statistical information bearing on uses of the sea.

"The scientific spirit . . . is perhaps the most profoundly distinguishing feature of our civilization." —BARBARA WARD

Chapter XIV

RESEARCH, MANPOWER, AND ENGINEERING

The foundation of our national marine science affairs program is a strong and vigorous base of scientific research—techniques and specialized knowledge of the classical scientific disciplines focused on unique problems of the ocean environment, a growing pool of highly talented manpower, and a creative engineering capability to translate scientific discovery into practical application. During the past decade Federal policies and programs have sustained development of this foundation—a Federal effort spread over many scientific and engineering disciplines and involving a wide variety of institutions.

The most significant advance in ocean sciences during the past 10 years has been the development of a national capability to study the ocean and ocean floor on a global basis. A key element has been the major increase in the number and quality of people and observation platforms available for that endeavor, but the heart of this accomplishment has been the intellectual synthesis of many fragments of data into a set of unified concepts of the marine environment.

Major advances in modern technology and engineering have provided more powerful tools to conduct research in the oceans and to answer scientific questions. This engineering should also provide a bridge to transfer scientific discovery to utilization and management of ocean resources. With our modern fleet of research ships and supporting laboratory facilities, we are able to observe, measure, and understand phenomena on a scale and

scope never before possible. Scientists in submersibles and aqualungs can make direct observations in surface layers as well as deep within the oceans. Improved geophysical tools such as seismic profilers, magnetometers, and gravimeters enable us to "see" geological features in greater detail and at greater distances below the bottom. Continuous recording devices make possible the automatic determination of many ocean parameters. Improved satellites, ships, aircraft, buoys, navigation systems, computers, and other devices have greatly increased our ability to collect and analyze data from the oceans.

Recent Scientific Advances [1]

Recent technological advances have enabled us to obtain a new understanding of fundamental marine geological and geophysical phenomena. A striking achievement was the discovery of a ridge-rift system throughout all ocean basins, with its associated magnetic reversals and high heat flow. From this discovery has evolved the important new concept of sea floor spreading, which provides an important key for finally solving the problem of the origin and development of ocean basins and continents as well as for unraveling the earth's structural history and continued evolution on a global scale. Also, the recently developed capability to drill through the complete sedimentary column wherever it is relatively thin into underlying basement rock in the deep ocean basins adds a new and important dimension to our understanding of the geology and resource potential of ocean basins.

In physical oceanography, investigations of fluid dynamics in rotating frames are providing a basis for eventual development of numerical models of oceanic circulation. Also, an array of new devices—expendable bathythermographs, salinity-temperature-depth recorders, and thermistor chains—is being used to obtain rapid and more detailed observations of the physical characteristics of the ocean. We can forecast temperatures in the oceans; we have discovered strong subsurface currents; we are able to observe tides in the deep ocean; we have increased our understanding of the overall energy budget of surface gravity waves in the ocean; and we have made many advances in our understanding of the physical processes that govern water contamination in estuaries and coastal regions.

In biological oceanography, a major achievement has been the development of a mathematical model, still undergoing refinement, which predicts phytoplankton, zooplankton, and nutrient salt concentrations in the

[1] Prepared with assistance of the Committee on Oceanography of the National Academy of Sciences.

upper, photic layer from phosphate concentrations at depth, mixing rates, and temperature. Recently developed techniques for determining the biological productivity of the sea have now been employed routinely in all of the major oceanic regions. We have a qualitative and quantitative understanding of the transfer of energy and matter within the "food web" of living organisms in the sea. New observations of ocean circulation, distribution of nutrients, and the interrelationships of organisms to physical and chemical variables have provided knowledge that allows the prediction of new exploitable stocks of fish. In the deep sea, new measurements of dissolved and particulate organic carbon show convincingly that both of these constituents are uniformly distributed at depths below a few hundred meters, both vertically and geographically.

In the field of geochemistry, new radiochemical techniques to determine sediment age have extended the useful limits of these measurements from about 30,000 years to 50 to 100 million years. Studies of manganese nodules suggest that the growth rates are of the order of a few millimeters per million years. Investigations of marine sediments have demonstrated that their mineral content reflects their source environment rather than their depositional environment, and thus give indications of the major terrestrial source regions for deep sea sediments. Finally, recent analytical refinements have established beyond doubt that man-made pollution has already affected surface layers of the ocean, everywhere.

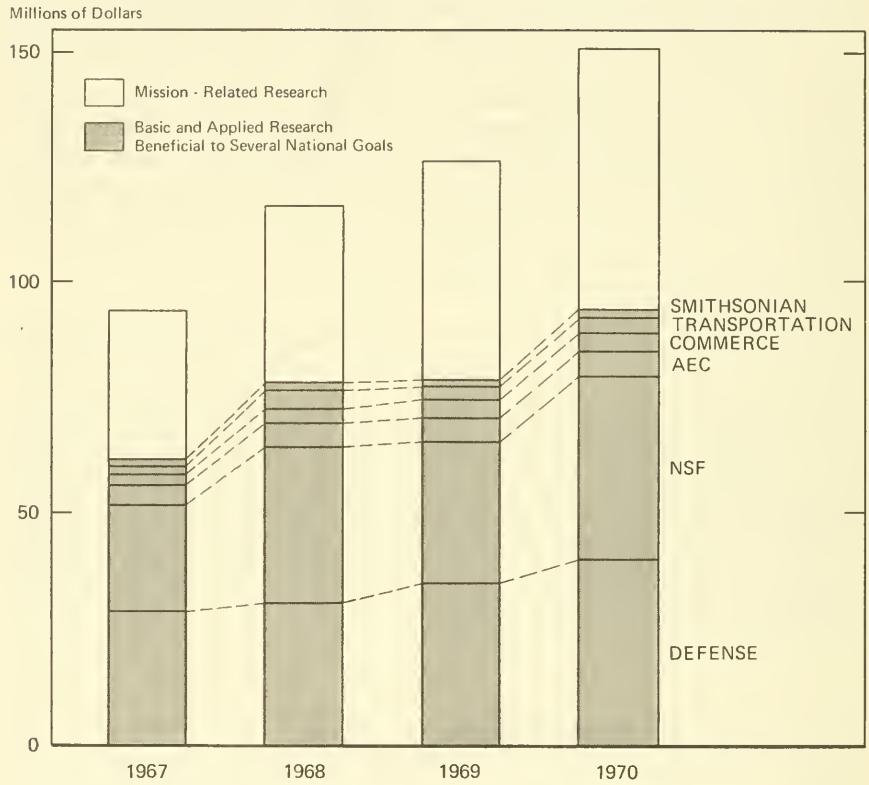
Federal Funding of Research and Facilities

These accomplishments have been made possible by investments in research conducted primarily at academic institutions over the last decade. Maintaining that support has been a Federal responsibility—one that has been difficult to implement during the past year when overall limitations on Federal expenditures were required by the Congress. Every sector of Federal activity has felt this necessary fiscal limitation, and every effort has been made to balance available funds among competing demands and between in-house and extramural activities.

The total Federal support of basic and applied marine research, including work performed by universities, industry, and government, is shown in Figure XIV–1. Research proposed for FY 1970 is about $24 million greater and research ship operation costs about $1.8 million greater than the appropriations for FY 1969. Many of these programs are discussed in other chapters.

The Navy, primarily through the Office of Naval Research, supports marine science research at almost 100 universities and colleges, private laboratories, and a dozen Navy laboratories. The Navy Ocean Science

Figure XIV-1—Funding for Oceanographic Research [a]



[a] Does not include ship construction.

Program represents a balance of multi-disciplinary research and development activities sponsored by the Office of Naval Research, the Naval Material Command, the Naval Oceanographic Office, the Bureau of Medicine and Surgery, and the Naval Weather Service Command to meet the Navy needs for understanding the ocean environment. Also, eight projects in marine sciences are included in the Department of Defense THEMIS program to assist in the development of new academic centers of excellence.

The National Science Foundation has increasingly supported marine research, facilities, and education at universities and oceanographic institutions. The NSF program:

—provides funds for ship construction and conversion;
—supports the construction of laboratory buildings, docking facilities, and other shore installations;
—supports basic research grants;
—assumes responsibility for approximately half of the ship operating costs at educational institutions;

—provides management for the U.S. Antarctic Oceanographic Research Program;
—funds a special program of deep ocean sediment coring; and
—supports special studies, fellowships, and conferences.

While the size of the research programs of other agencies is not as large as the Navy and NSF programs, they, too, contribute both to meeting the needs of individual agencies and to strengthening the national research base. Among the many programs included in the multi-goal research category are research on air-sea interaction, mathematical modelling and field investigations of ocean dynamics and the geological and geophysical structure of ocean basins (ESSA), radionuclide investigations (AEC), studies related to phenomena of currents (Coast Guard), and worldwide marine biological and geological expeditions and specimen analysis at facilities in the United States and abroad (Smithsonian).

In considering future needs and opportunities of marine research, it is becoming apparent that sharply increasing attention must be given to three problems: stability in support to academic institutions, adequacy of funding to cover ship operations and supporting facilities, and increased attention to nearshore ecology.

Research Areas of Special Emphasis

Four areas of federally supported research will receive special emphasis in FY 1970:

1. *Air-Sea Interaction.*—A numerical ocean-atmosphere interaction model has been developed which extends from depths of a few hundred meters in the ocean layer to heights of about a kilometer in the atmospheric layer. The principal processes included in the model are eddy fluxes in stratified flow, mixing due to wind-generated waves on the sea surface, and cloud-dependent radiative heating. Parallel to the model development, an instrument development program is continuing to improve capabilities for measuring the important parameters in the lower atmosphere and upper ocean.

As part of the Federal program for air-sea interaction research, a Barbados Oceanographic Meteorological Experiment—BOMEX—will be conducted from May to July 1969 in the area east of Barbados with funding and participation by seven Federal agencies.[2] During the past year an instru-

[2] Departments of Commerce, Defense, Interior, and Transportation, Atomic Energy Commission, National Aeronautics and Space Administration, and National Science Foundation.

ment evaluation field project in the vicinity of Barbados served to test and evaluate equipment to be used in the 1969 BOMEX effort and collect preliminary meteorological/oceanographic data.

2. *Antarctic Oceanography.*—Oceanographic studies will continue in the southern oceans, between latitude 45° S. and the shores of Antarctica. The *Eltanin* will be committed to multi-disciplinary research efforts during the FY 1970 season in the southern Indian Ocean area south of latitude 45° S., an area which was not included in the International Indian Ocean Expedition. The new research vessel *Hero,* to be based in Antarctica, will be operating in the Antarctic Peninsula areas. It will concentrate on biological trawling, including studies of the population and distribution of the krill, and investigations of seals and whales. The ice breaker *Glacier* will continue investigating bottom water movement, taking cores, and collecting oceanographic data in the Weddell Sea. All of these programs are being carried out in cooperation with Chile, Argentina, and other nations interested in the area.

3. *Deep Ocean Drilling.*—The purpose of the Ocean Sediment Coring Program is to obtain core samples by drilling entirely through the sediment layer of the deep ocean floor to explore the uppermost layer of the earth's crust under the sea. The program involves scientists and technologists from academic institutions, private industry, and government agencies. While it was planned primarily to advance basic science, the discovery of petroleum in the deep ocean floor of the Gulf of Mexico during the first few weeks of drilling has industrial and technological implications. Also, a bore-hole was drilled in the floor in more than 17,000 feet of water, within the first few weeks, and at other locations more than 2,500 feet of deep ocean sediment were successfully penetrated.[3]

The program will include reconnaissance surveys of the Atlantic and Pacific Ocean basins from the *Glomar Challenger* shown in Figure XIV–2. It envisages investigations of mid-ocean ridges, rift escarpments, abyssal plains, and continental rises. The preliminary analysis of the core material

[3] On Aug. 19, 1968, in 11,720 feet of water, drilling penetrated the seabed to a depth of 472 feet and bottomed in material consisting of calcium sulfates (gypsum and anhydrite), pyrite, lime, and free sulfur, the typical minerals of the caprock of a salt dome. In addition, partly in the caprock and partly in a sandy bed just above it, the cores indicated presence of liquid petroleum and some gas. The hole was immediately plugged and cemented to prevent seepage of the oil. In addition, a bore-hole was drilled in the floor in 17,567 feet of water (a drilling record for a free-floating platform) east of San Salvador, and samples of Jurassic sediments, 15 million years older than any sedimentary rock previously found in the deep oceans, were obtained from the San Salvador site.

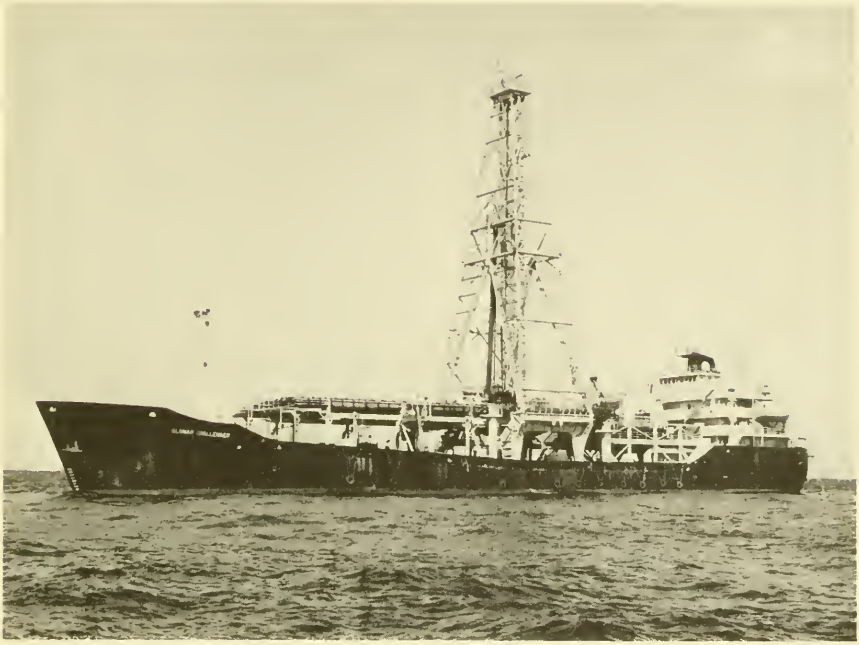


Figure XIV–2—*The new deep sea drilling ship GLOMAR CHALLENGER, is currently carrying out a program for drilling between 40 and 60 holes in water depths ranging from 5,000 to 20,000 feet in the Atlantic and Pacific Oceans. This program, involving government, industrial, and academic scientists, is directed to gaining new insights into the history and nature of the ocean basin through investigation of sediments and basement rock to depths of 2500 feet below the ocean floor.*

and samples will be distributed to individual scientists who will pursue individual specialized research projects.

4. *Utilization of Deep Submersibles.*—The United States has an existing fleet of industry-owned, deep submersibles which represents a significant capability for ocean research and exploration. Recognizing the potential of these submersibles to contribute to both science and marine resource development and thus to strengthen initial programs for the International Decade of Ocean Exploration, the Council recommended and the Navy established a program to lease submersibles from industry for exploration projects of government-wide interest. It is tentatively planned that submersibles will be leased centrally for use by government and academic scientists who demonstrate a priority requirement for the use of these facilities. The Office of Naval Research will sponsor the program with $3 million requested for FY 1970, and the Council's Committee on Marine Research, Education, and Facilities will monitor the program.

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Manpower Training and Education

In recent years, the Federal Government as a matter of national policy has assumed a major responsibility for the support of training and education through a wide range of fellowships, training grants, research, and institutional programs. Graduate enrollments and the number of degrees granted annually in the field of oceanography have increased substantially during recent years as shown in Table XIV–1, a gratifying product of investments in oceanography in the early 1960's. Support for education of marine science technicians and ocean engineers, however, appears to have lagged behind needs. The importance of technicians may have previously been underestimated. Similarly, a need has developed for additional systematists to assist in analyzing marine data.

Table XIV–1—Graduate Degrees in Ocean Science and Engineering

Academic year	Marine Science [a]			Ocean Engineering [b]		
	Number of schools [c]	Degrees granted (enrollment in parentheses)		Number of schools [c]	Degrees granted (enrollment in parentheses)	
		M.S.	Ph. D.		M.S.	Ph. D.
1960–61	27	63 (160)	44 (117)	.....	.....	.....
1961–62	25	53 (243)	51 (224)	.....	.....	.....
1962–63	27	62 (301)	44 (322)	.....	.....	.....
1963–64	32	115 (419)	61 (345)	.....	.....	.....
1964–65	34	125 (460)	85 (452)	2	1 (1)	(2)
1965–66	38	135 (560)	90 (549)	4	11 (27)	4 (20)
1966–67	42	192 (791)	114 (602)	7	18 (57)	5 (36)
1967–68 [d]	50	294 (1034)	172 (754)	8	53 (152)	11 (63)

[a] Includes schools offering marine-related basic science.
[b] Includes schools offering marine options to basic engineering curricula.
[c] Offering the Master's Degree; the number offering Doctorates is slightly smaller.
[d] Degrees granted in 1967–68 were estimates by the Institutions.

Source: Committee on Marine Research, Education, and Facilities.

Federal support of education in the marine sciences is carried on primarily through programs of the National Science Foundation and HEW's Office of Education. The principal NSF programs are:

—Graduate Education Development Programs
—Traineeships and Fellowships Programs
—College Teacher Programs
—Undergraduate Education Development Programs
—Undergraduate Student Programs
—Secondary School Teacher Programs
—Pre-college Education Development Programs
—Secondary School Student Programs

The major Office of Education programs are:

—Fishery trades and industry support for vocational education (George Barden Act)

—College teacher fellowships (National Defense Education Act)

—Higher education facilities in support of marine science (Higher Education Facilities Act)

—Equipment grants in support of undergraduate education in the marine sciences (Higher Education Act)

—Supplementary projects in marine science in elementary and secondary education (Elementary and Secondary Education Act).

In addition, the Bureau of Commercial Fisheries has sponsored several graduate fellowships and the Smithsonian Institution provides stipends for academic year and summer research training. These four agencies support programs as follows:

(In millions of dollars)

	FY 1968	FY 1969	FY 1970
Department of Health, Education, and Welfare	1.2	1.5	1.5
Department of the Interior	0.1	0.1	0.1
Smithsonian Institution	[a]	[a]	[a]
National Science Foundation [b]	2.0	1.5	1.5

[a] Less than $50,000.

[b] Sea Grant funds also supported education and training (Table X–1).

Additionally, a significant part of the research grants of several agencies is used to support graduate students.

The Departments of Commerce, Defense, and Transportation support graduate training and education for their civilian employees to aid in career development. In addition, the Navy operates its own two-year postgraduate school at Monterey, California, and sends selected officers to civilian schools for oceanographic specialization. The Coast Guard operates an oceanographic technician school which will be expanded to a 21-week program this year. Federal programs are funded as follows:

(In millions of dollars)

	FY 1968	FY 1969	FY 1970
Department of Commerce	0.1	0.1	0.1
Department of Defense	1.4	1.6	1.8
Department of Transportation	0.2	0.2	0.2

One concern is whether the demand for talent may outstrip the supply. No precise methodology exists for projecting needs, and supply is hard to estimate because of field switching by more than half of the present par-

ticipants. There is nevertheless a need for a basic core of individuals trained in ocean sciences as well as provision of postdoctorate opportunities for those based in classical disciplines. A special study of these needs for the International Decade of Ocean Exploration is planned.

Providing Opportunities for the Disadvantaged

The Council recognized that expanding manpower requirements in the marine sciences, particularly for technicians, offer new opportunities for disadvantaged persons. During the summer of 1968 about 1,000 disadvantaged persons participated in the marine science programs of Federal agencies within the framework of the Youth Opportunity Campaign, the Neighborhood Youth Corps, and similar programs. Also, grants of the Department of Labor and Office of Education, totalling more than $300,000, are being used for training 120 unemployed young people in the Washington, D.C., area as oceanographic aides. The decommissioned ESSA survey ship *Explorer* has been tied up in Washington as a training facility for this project.

After a preliminary survey of these and other opportunities, the Council directed its Committee on Marine Research, Education, and Facilities to further enhance technician job opportunities by:

—developing definitions of marine technicians in terms of duties and education and training required;

—developing curricula guides for training marine technicians; and

—developing, in cooperation with the Department of Labor, an improved description of marine-related jobs to be included in Labor's *Occupational Outlook Handbook.*

Also, the Committee was directed to develop programs to:

—place disadvantaged high school youths in jobs as science aides in scientific and engineering research laboratories to develop college motivation, in cooperation with Federal marine laboratories; and

—encourage major marine industries to create jobs for the disadvantaged and hard-core unemployed by setting up secondary manufacturing concerns.

The Growing Importance of Ocean Engineering

As we emphasize more effective use of the sea, the role of ocean engineering in bridging the gap from scientific discovery to practical application takes on increased significance. General purpose ocean engineering is a term

adopted for engineering research and development that can be applied to a variety of purposes, often spanning the missions of two or more Government agencies. However, the inventory of modern, reliable, "ocean-engineered" components and operating systems is relatively sparse in this newly developing area. Further, insufficient experience exists to enlarge it quickly. Our ocean-engineered devices and systems have not yet approached high levels of design reliability and versatility. This is largely because the special problems associated with engineering in the ocean and the need for thorough testing and development procedures have been adequately recognized only recently.

Although ocean engineering capabilities continue to lag behind needs, growing recognition of the importance of this field has been reflected in many advances. Table XIV–2 presents the funding for Federal programs categorized as ocean engineering in this Report. The ocean data buoy program is discussed in Chapter XII, and coastal engineering activities are described in Chapter IV.

Table XIV–2—Funding for General Purpose Ocean Engineering

(In millions of dollars)

Activity and supporting agency	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
Ocean engineering (Defense)	11.2	13.2	14.4
Ocean data buoy program (Coast Guard)	0.1	0.6	9.8
Nuclear power (Atomic Energy Commission)	7.9	4.5	5.3
Instrumentation facility (Navy) [a]	1.2	1.2	1.8
Total [b]	20.4	19.5	31.3

[a] Item included as a National Security subcategory in Appendix A.

[b] An additional $5 million, approximately, is spent each year on Naval instrumentation development and is included within other major purpose categories.

1. *Deep Ocean Technology Development.*—The Navy program continues to be the cornerstone of the Federal effort. It includes advanced engineering related to material, power, propulsion, fabrication, soils, vehicles, habitats, and instrumentation. The focal point for this program is the Council-endorsed Deep Ocean Technology Project—proposed by the Navy as a 10-year program to provide validated technical options in support of future naval systems.

Work is currently underway in unmanned recovery systems, submersible electric drive systems, massive glass development, titanium pressure hulls, hydraulic fluids, and sea floor engineering. The Cable Controlled Underwater Research Vehicle (CURV III) prototype system, consisting of a submersible vehicle, control van, and support platform, is scheduled to be in

the water for check-out early this year. The CURV III will be a research and development tool suitable for adaptation to many types of undersea work as well as weapon recovery to 7,000 feet. This is an interim goal in the long-range plan to develop remote unmanned work systems for 20,000 feet.

A Deep Ocean Test Instrument Placement and Observation System is now ready for service. It has a 7,000-foot depth capability, is equipped with a TV camera, still cameras, a data and command telemetry package, and flood lights, and can provide 15 KW electrical power on the bottom. This device will provide for monitoring and control of engineering investigations on the sea floor.

The recent loss of two SNAP–19 nuclear generators from an aborted NIMBUS space launch and their subsequent recovery in 300 feet of water, using a submersible, off the California coast emphasized the importance of an ocean engineering capability.

Other developments in the Navy program during 1968 included:

—environmental testing of electric motors and insulating fluids to study electrical characteristics as affected by contaminants and pressure cycling;

—initiation of a development plan for glass pressure hulls;

—testing of explosion-actuated anchor with a holding power of 50,000 pounds in 1,300 feet of water;

—progress in fabrication techniques for using titanium in deep submergence vehicles;

—laboratory testing of a 5½-foot diameter, clear plastic sphere intended to carry an observer to a depth of 600 feet;

—development of semi-automatic, portable, ultrasonic testing devices for detecting internal discontinuities in hulls and hull weldments;

—launching of the deep research vehicles *Sea Cliff* and *Turtle* with a depth capability of 6,500 feet; and

—initiation of construction of an ocean simulation laboratory, capable of testing entire unmanned diving systems and equipment subsystems to depths of 2,000 feet.

Of particular interest is an industry-government program, TEKTITE, sponsored by the General Electric Company and by Interior, Navy, Coast Guard, NASA, and the Smithsonian Institution, to place four scientists on the ocean floor under saturated diving conditions for a period of 60 days. This program will provide data on man living and working under stressful, isolated conditions in a shallow water, ambient temperature habitat. New engineering technology in the emplacement and operation of large habitats on the ocean floor will be developed, with operation of the program scheduled this year near the Virgin Islands.

Complementing government efforts during the past year were submersible development activities of industry, marked by the completion of

Lockheed's *Deep Quest;* General Motors' *Deep Ocean Work Boat;* and Grumman's *Benjamin Franklin,* which is scheduled to explore the Gulf Stream in 1969.

2. *Power for Underwater Tasks.*—Effective, reliable power sources tailored to the mission involved are essential to all ocean systems; requirements will range from microwatt to multikilowatt capacities, from days to years of service life, and from use in fixed installations to submersibles.

The AEC program to develop radioisotope power sources continued in 1968 with emphasis on radioisotope power sources in a range of 10 to 100 watts capable of 5 to 10 year unattended operation. Several 10-watt deep ocean prototype devices (SNAP–21) were fueled and are being prepared for environmental testing. These units incorporate high performance static thermoelectric converters which have demonstrated stable operation under laboratory conditions for periods approaching 10,000 hours. Important progress was also made in the design and development of similar radioisotope devices in the 50 to 100 watt range (SNAP–23) which are intended for use in ocean buoys and in remote terrestrial environments. In regard to high powered multikilowatt power requirements associated with fixed underwater laboratory stations and active ASW sonar networks, AEC has initiated preliminary design studies and program planning relating to the development of strontium-90 or cobalt-60 radioisotope power plants and small pressurized water reactors.

Testing hydrogen-oxygen fuel cells and hydrazine-hydrogen peroxide fuel cells under deep ocean conditions continued in Navy laboratories, and contracts were let to two companies leading to design and development of a fuel cell power system for deep submergence vehicles.

3. *A National Instrumentation Facility.*—The Council recognized that there is no central oceanographic instrumentation facility to serve Federal and non-Federal interests. Basic standards for instrument measuring do not exist; calibration of instruments is not uniform; information on instrument design and performance is not readily available; the general reliability level of instruments is low; and there is a need for a stronger national focal point for participating in development of international standards. While the Naval Oceanographic Instrumentation Center has attempted to meet national needs, this service has been limited by uncertain interagency use, possible pre-emption by priority Navy needs, and lack of capability to meet expanding demands for services.

The Council has approved recommendations to strengthen instrumentation capabilities by establishing a National Oceanographic Instrumentation Center, on an interim basis, composed of the following elements:

—The National Bureau of Standards will begin to establish a capability to perform primary oceanographic instrumentation standards functions.

—The Naval Oceanographic Instrumentation Center will undertake national coordination and information exchange functions and will continue its national instrument development test and calibration functions to the extent permitted by Navy budgets and reimbursable tasks.

—An Advisory Board of representatives of Federal agencies and a Consultative Committee including representatives of the academic and industrial sectors are being established.

4. *Gaps in Technology.*—In the military field, the development of deep ocean technology is uneven—partly because the strategic uses and the need for deep ocean capabilities have not been clearly identified. For example, fixed military installations at depths down to 6,000 feet may become desirable over the next 5 to 10 years, yet power supplies and a number of other developments required for such projects are not yet available. Man-in-the-Sea capability has progressed rapidly, but there is still need for effective hand tools, communication and navigation for swimmers in water which is sometimes opaque, and additional pressure test facilities.

While ocean engineering for recovery of offshore petroleum products continued to advance in many respects, an inadequate base of marine technology exists for most non-military applications. Accurate position fixing on the surface and under the sea, reliable instrumentation, a better understanding of seabed soil mechanics, technology for power sources, and improved dissemination of engineering information are some of the more urgent needs.

Engineering Developments To Promote Safety at Sea

In recognition of the intensified activities along our coasts, the Council endorsed three engineering programs designed to facilitate safe maritime activities and assigned to the Coast Guard lead agency responsibility for these programs.

1. *Safety within the Sea.*—To insure that expanding activities of civilian submersibles are conducted safely, minimum requirements for safe operations are being considered. Measures might include inspection of undersea vessels and structures, licensing of operators, and development of a capability to rescue personnel from submersibles in distress. In carrying out this program, the Coast Guard established a special projects office which is considering draft legislation concerning minimum safety regulations for submersibles regardless of size, tonnage, or number of passengers. Such regulations could provide reassurance to those interested in utilizing submersibles for further exploration and work at sea, thus making submersibles a more marketable item. Criteria will be formulated in FY 1970 to facilitate

safe design and construction of submersibles. Specific research will be directed toward the effect of pressure hull penetrations, development of test models and full-scale sections for evaluation, determination of life support equipment and emergency procedures, and investigation of requirements for submersible environmental control. Also, the Coast Guard is cooperating with industry in developing an interim capability to rescue a distressed submersible by use of other non-governmental submersible facilities.

2. *Study of Acoustic Frequency Allocations.*—The Coast Guard has initiated a study of future non-military needs for underwater acoustic frequencies and the necessity for frequency standardization and regulation, including consideration of distress signals and general underwater communication. The National Academy of Sciences is assisting in the study which will be completed this year.

3. *Safety on the Continental Shelf.*—Conflicts between various coastal activities will increase with expanding activity, with resultant hazard to life and property. Many of these pursuits are beyond the purview of or are only vaguely covered by existing safety legislation. Therefore, the Coast Guard is considering steps, including the possible need for additional legislation, consistent with international law and practice, related to:

—establishment of design standards and certification procedures for Continental Shelf structures and devices to reduce the likelihood of collapsing structures, bursting oil containers, or other structural accidents;

—elimination of wrecks, debris, pollutants, and litter on the Continental Shelf which may be a hazard to life or property or an interference to useful activity; and

—minimizing conflicts among the various activities including shipping, transfer of liquid or gases in pipelines, fishing, recreation, drilling, pumping, and storing materials underwater or at the surface.

These measures will contribute to the development of the Coastal Zone discussed in Chapter IV.

"We must sail sometimes with the wind and sometimes against it—but we must sail, and not drift, nor lie at anchor."

—OLIVER WENDELL HOLMES

Chapter XV

NATIONAL POLICY PLANNING AND COORDINATION

From the foregoing discussion it should be clear that marine science affairs embrace a wide range and diversity of public purposes, institutions, specialized bodies of knowledge, and Federal activities that are parts of the missions of 11 departments and agencies. A need was recognized within the Congress as early as 1960 to turn this fragmented, frequently unsteady, and loosely knit collection of programs into a broadly based, coordinated, and continuing national effort. Some members of Congress also believed there was an absence of a sense of urgency and of a sustaining focus for national leadership.

Enactment on June 17, 1966, of the Marine Resources and Engineering Development Act (P.L. 89–454) thus became a turning point in Federal administration of marine science affairs. More than 30 legislative proposals since the 86th Congress were combined to provide:

—a clear statement of national purpose;

—a new emphasis on Presidential leadership;

—an interim cabinet-level Council to assist the President in policy planning and coordination with a full-time professional staff independent of agency ties; and

—a public advisory Commission to identify the Nation's stake in the oceans and to recommend the next steps for the national program.

P.L. 89–454 also gave the President responsibility for implementing the legislation by:

—developing a comprehensive marine science program involving Federal agencies working in cooperation with the entire spectrum of non-Federal organizations including State and local governments, private research institutions, and industry;
—conducting long-range studies of the potential benefits to our economy, security, health, and welfare from ocean activities and of the legal aspects of resource management; and
—evaluating the total national program in terms of the legislative mandate and reporting annually to the Congress on accomplishments, budgets, and needed legislation.

Developing a Concerted National Effort

To advise and assist the President with these tasks the statutory National Council on Marine Resources and Engineering Development was promptly activated. Since its initial session August 17, 1966, the Council has met 15 times. The Vice President, who serves as Chairman, has presided at 12 sessions.

The Council has endeavored to: (a) identify unmet needs and opportunities to which Federal marine science programs could be directed, especially gaps in programs that cross agency lines; (b) recommend priorities on a government-wide basis by selecting areas deserving additional emphasis; (c) identify impediments to progress and strategies for their circumvention; (d) develop policies by which the objectives and programs of one agency will not inadvertently conflict with equally valid but independent activities of another; (e) recommend—in those cases where missions of several agencies may overlap—that one agency assume a lead responsibility for government-wide planning, guiding, coordinating, and assuring fiscal support; (f) coordinate—through a committee structure—programs which are of concern to many agencies; (g) insure that the appropriate resources of the Federal Government are brought to bear on mutually agreed upon goals; (h) evaluate programs so as to eliminate marginal activities; and (i) develop background, legal, economic, and technological studies for identifying alternative policies and criteria for choice.

The Council has also carried out policy planning functions for the Sea Grant Program, established by P.L. 89–688 and administered by the National Science Foundation, and coordinated Federal programs of international cooperation, such as the International Decade of Ocean Exploration.

The Council Chairman developed a number of concepts concerning the Council's role and method of operating:

—The Council's key function should be to assist the President in carrying out his statutory leadership responsibilities, not to serve as an operating agency.

—It should aid in strengthening the programs of the agencies and in coordinating activities so as to foster an enterprise stronger than the sum of its parts.

—Its scope of activity, in keeping with the spirit of the legislation to take into full account all the uses of the oceans, should be broader than the programs of scientific oceanography which had been coordinated by its predecessor, the Interagency Committee on Oceanography of the Federal Council for Science and Technology.

—The Council should give high priority to the institutional framework and governmental processes by which science converges with considerations of law, socio-economics, and public policy and should seek new ideas within and outside government.

Also underlying the Council's activities have been three fundamental concepts, namely:

—While the Government provides much of the leadership and support for ocean research and exploration, the development and exploitation of marine resources is the responsibility of private enterprise.

—State and local participation is critical to the successful management of activities in the coastal marine environment.

—In view of the inherently international character of the oceans, a multinational approach to many uses of the sea is essential.

A major consequence of the establishment of the Council has been the elevation of major issues of national importance to consideration at a government-wide policy level and selection of those priority matters deserving Presidential attention. These priority recommendations have reached the President in the context of broadly based national goals as well as in terms of agency missions and priorities.

Some 65 policy issues have been considered by the Council. The Council's action has in turn been reflected in Presidential statements, new initiatives set forth in this and the two previous Annual Reports, and special budgetary emphasis. In brief, the Council has considered its major functions to be identification of goals from numerous and diffuse alternatives; mobilization of fragmented, and often dormant, resources into a coherent multiagency framework directed toward these goals; and formulation of priorities and action programs to achieve these goals.

To assist in preparing recommendations on issues requiring Council-level action and to foster exchange of information and coordination of policies and programs, the Council established four interagency committees which report to the Vice President: Marine Research, Education, and Facilities; Ocean Exploration and Environmental Services; Food from the Sea; and Multiple Use of the Coastal Zone. Additionally, at the request of the Vice

President, the Secretary of State established a fifth committee on International Policy in the Marine Environment to serve the mutual interests of the Council and the Department of State. The responsibilities of these committees are outlined in Table XV–1, and some of their activities have already been discussed in relation to specific policy issues.

The Marine Sciences Council's professional staff of 13 persons includes specialists in ocean sciences, engineering, national security affairs, public administration, law, economics, and international relations. The Council staff assists in identifying policy issues, developing and analyzing background material, and proposing alternatives for Council deliberation and action. Also, 40 percent of the Council's budget is used to obtain additional advice through contract studies and from more than 70 consultants.

Preparation of Council Reports

Another major task of the Council has been preparation of these Annual Reports to the President which he transmits to the Congress as called for in P.L. 89–454. The report includes:

—a description of government-wide programs with funding and activities delineated by purpose as well as agency;
—an evaluation of agency programs in terms of statutory objectives;
—an abstract of individual agency accomplishments, including a progress report on implementation of earlier Council initiatives;
—justification for new Federal initiatives and the marine science program as a whole;
—recommendations for new legislation; and
—discussion of unresolved issues—especially those deserving further study by non-Federal as well as Federal interests.

After drafting by the Council staff, the Report is reviewed by Council members and observers. At that time unresolved issues, unclear jurisdictions, and controversial programs are clarified and resolved.

By its scope and content, the Report serves as a planning document to assist the Federal Government at various echelons to focus on common goals. It is intended to aid Congress in relating diverse elements of the program presented to more than 20 appropriations subcommittees and an equal number of legislative subcommittees concerned with the complex matrix of marine science affairs. The Report should also assist industry, academia, State and local governments, and foreign nations concerned with relating their goals and programs to our national effort.

As indicated in Table XV–2, the Council has also released reports and general background information concerning activities such as oceano-

Table XV–1—Committees of the Marine Sciences Council

The Committees of the Council have the general responsibility of advising and assisting the Vice President and the Council in those fields of marine science and technology within their jurisdiction and involving more than one agency. Within this framework, they analyze current and future activities of the Federal agencies, identifying problems, deficiencies, needed reorientation or emphasis in the light of public needs. They undertake studies and submit recommendations to the Council, either as assigned or on their own initiative. Those activities for which one agency has sole responsibility do not fall within the Committees' jurisdiction.

Committee	Responsibility	Chairman
Committee on Marine Research, Education, and Facilities.	Basic oceanographic research and engineering, and related vessels, equipment and facilities for Federal activity in marine research; manpower and specialized education in the marine sciences, including the Sea Grant Program.	Robert A. Frosch, Assistant Secretary of the Navy for Research and Development.
Committee on Ocean Exploration and Environmental Services.	Exploration, description, and prediction of the marine environment and the ships, buoys, satellites and other facilities required for these purposes; mapping, charting, and data management activities.	Robert M. White, Administrator, Environmental Science Services Administration.
Committee on Food from the Sea.	The broad, long-range program, adopted by the Council and the President in early 1967, to exploit the oceans in every reasonable way as a source of food, including the Fish Protein Concentrate Demonstration Program.	Rutherford M. Poats, Deputy Administrator, Agency for International Development.
Committee on Multiple Use of the Coastal Zone.	Environmental planning, conservation, and development; water pollution, erosion control, and shore development activities; channel and harbor development and redevelopment; marine ecology; and recreational development of marine areas.	Clarence F. Pautzke, Assistant Secretary of the Interior for Fish and Wildlife and Parks.
Committee on International Policy in the Marine Environment.[1]	U.S. foreign policy pertaining to the marine environment; international activities and initiatives pertaining to the marine environment, including cooperation by the United States with other nations and participation in international organizations and meetings.	Charles E. Bohlen, Deputy Under Secretary of State.

[1] Established by the Secretary of State, at the request of the Vice President, to serve the mutual interests of the Council and the Department of State.

graphic ship operating schedules, university curricula in oceanography, potential of spacecraft oceanography, and marine science activities of some 100 countries. In addition, a number of contract studies have been undertaken to develop information and analytical tools for policy planning of programs that cross agency lines (Table XV–3).

Table XV–2—Reports of the Marine Sciences Council

Title	Date
Marine Science Affairs—A Year of Transition: The First Report of the President to the Congress on Marine Resources and Engineering Development.	February 1967 [a]
Aquatic Sciences in the Great Lakes Area	March 1967 [a]
Oceanographic Ship Operating Schedules, 1968	July 1967 [b]
University Curricula in the Marine Sciences, Academic Year 1967–1968.	August 1967 [b]
Addendum to University Curricula in the Marine Sciences, Academic Year 1967–1968.	August 1967 [b]
United States Activities in Spacecraft Oceanography	October 1967 [a]
Marine Science Affairs—A Year of Plans and Progress: The Second Report of the President to the Congress on Marine Resources and Engineering Development.	February 1968 [a]
Marine Science Activities of Canada and the Nations of Europe	April 1968 [a]
Marine Science Activities of the Nations of East Asia	April 1968 [a]
Marine Science Activities of the Nations of Latin America	April 1968 [a]
Marine Science Activities of the Nations of the Near East and South Asia.	April 1968 [a]
Marine Science Activities of the Nations of Africa	April 1968 [a]
Oceanographic Ship Operating Schedules, 1968	April 1968 [b]
International Decade of Ocean Exploration	May 1968 [a]
Oceanographic Ship Operating Schedules, September 1968–February 1969.	August 1968 [b]
Marine Science Affairs—A Year of Broadened Participation: The Third Report of the President to the Congress on Marine Resources and Engineering Development.	January 1969 [a]

[a] For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
[b] Available from Council's Committee on Marine Research, Education, and Facilities, Building 159–E, Room 476, Navy Yard, Washington, D.C. 20390.

Thus a key role of the Council has been to inform interests other than those in the Executive Branch about marine science affairs. One major element of this information function concerns testimony before the Congress. Apart from individual consultations, since August 1966 the Council's Executive Secretary has been requested to testify, as summarized in Table XV–4, to:

—interpret and support the President's government-wide program;
—support budgets of the Council;
—support individual agency appropriations that have government-wide benefits; and
—explain the Administration's position on such matters as the International Decade of Ocean Exploration.

Table XV–3—Contracts Awarded by the Marine Sciences Council

Subject	Contractor	Amount	Report No. [a]
			4
International legal problems of ocean research.	William T. Burke, Ohio State University.	$7, 100	PB 17772
Law for sea's minerals.....	Louis Henkin, Columbia Law School.	$10, 000	PB 177725
Potential of spacecraft oceanography.	General Electric, Valley Forge, Pa.	$59, 433	PB 177726
Potential of aquaculture....	American Institute of Biological Science, Washington, D.C.	$30, 756	PB 177767 PB 177768
Encouraging marine resource development. [b]	National Planning Assoc., Washington, D.C.	$30, 000	PB 178203
Systems analysis of specified trawler operations.	Litton Industries, Beverly Hills, Calif.	$89, 373	PB 178661 PB 178662
Nonmilitary needs for underwater technology.	Southwest Research Institute, San Antonio, Tex.	$63, 000	PB 178687
International law and fishery policy.	Paul W. Dodyk, Columbia Law School.	$7, 425	PB 179427
Multiple use of Chesapeake Bay.	Trident Engineering Associates, Annapolis, Md.	$31, 112	PB 179844
Economic potential of U.S. continental margin.	Economic Associates, Inc., Washington, D.C.	$70, 000	PB 180118
Management of marine data systems.	System Development Corp., Santa Monica, Calif.	$75, 000	AD 673992 673993
Evaluation of marine resource statistics.	Surveys & Research Corp., Washington, D.C.	$6, 400	
Outline of marine legal conflicts.	William L. Griffin, Washington, D.C.	$4, 200	
International Indian Ocean Expedition.	Robert G. Snider, State College, Pa.	$6, 000	
Legal aspects of coastal land-sea interface.	Albert Garretson, New York University Law School.	$20, 000	
Legal aspects of Great Lakes resources.	.....do.....	$20, 000	
Seminar on liability aspects of marine activities.	American Trial Lawyers Association, New York, N.Y.	$1, 000	
Multiple use of the Greater Seattle Harbor.	Management & Economics Research, Inc., Palo Alto, Calif.	$35, 235	
Conference on future of fishing industry.	University of Washington, Seattle, Wash.	$5, 000	
Multiple use of Lakes Erie and Superior.	National Planning Association, Washington, D.C.	$41, 194	
Multinational investments in marine sciences.	Institute of Politics and Planning, Washington, D.C.	$25, 000	
Catalogue of marine research.	Smithsonian Institution, Washington, D.C.	$43, 186	
Science and engineering aspects of Decade of Ocean Exploration.	National Academies of Sciences and Engineering, Washington, D.C.	$50, 000	
Gulf of Mexico Research and Environmental Program.	Gulf Universities Research Corp., Houston, Tex.	$10, 000	

[a] Reports available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151.
[b] Jointly sponsored with National Science Foundation.

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Table XV-4—Congressional Testimony on Government-Wide Issues*

Date	Topic	Committee
10/10/66	Council program and budget for Fiscal Year 1967.	*House*—Subcommittee on Supplemental Appropriations (a)
10/17/66	Council program and budget for Fiscal Year 1967.	*Senate*—Subcommittee on Deficiencies and Supplementals (a)
3/13/67	Council program and budget for Fiscal Year 1968.	*House*—Subcommittee on Interior and Related Agencies (a)
3/17/67	Council program and budget for Fiscal Year 1968.	*Senate*—Subcommittee on Interior and Related Agencies (a)
8/17/67	Review of Council activities on first anniversary of Council.	*House*—Subcommittee on Oceanography (b)
10/11/67	H.R. 13273, to extend deadline for Commission report and lifetime of the Council.	*House*—Subcommittee on Oceanography (b)
11/28/67	S. 1262, to authorize Corps of Engineers shoreline study.	*Senate*—Subcommittee on Flood Control, Rivers and Harbors (c)
2/19/68	H.R. 15224, improvements for Coast Guard including research vessel.	*House*—Subcommittee on Coast Guard, C & GS, and Navigation (b)
3/ 7/68	Council program and budget for Fiscal Year 1969.	*Senate*—Subcommittee on Interior and Related Agencies (a)
3/13/68	Council program and budget for Fiscal Year 1969.	*House*—Subcommittee on Interior and Related Agencies (a)
4/ 9/68	H.R. 15490, to increase appropriation for FPC pilot plant.	*House*—Subcommittee on Fisheries and Wildlife Conservation (b)
5/27/68	H.R. 11584, *et al*, to establish system of marine sanctuaries.	*House*—Subcommittee on Oceanography (b)
6/24/68	H.R. 13781, to extend authorization of the Sea Grant Program.	*Senate*—Committee on Commerce
6/26/68	S. 3030, *et al*, to enable BCF to proceed with FPC plant.	*House*, Subcommittee on Fisheries and Wildlife Conservation (b)
7/29/68	H. Con. Res. 803, to express concurrence with objectives of International Decade of Ocean Exploration.	*House*—Subcommittee on Oceanography (b)

*Testimony by Executive Secretary, Marine Sciences Council.

(a) Committee on Appropriations.

(b) Committee on Merchant Marine and Fisheries.

(c) Committee on Public Works.

Communicating with Non-Federal Institutions

In addition to Federal participation in conferences and other meetings involving the marine science community throughout the country, the Council sponsored several meetings to bring the views of the non-Federal sector more directly into the mainstream of public policy. As indicated in Figure XV–1, the marine science community involves a very large number of organizations.

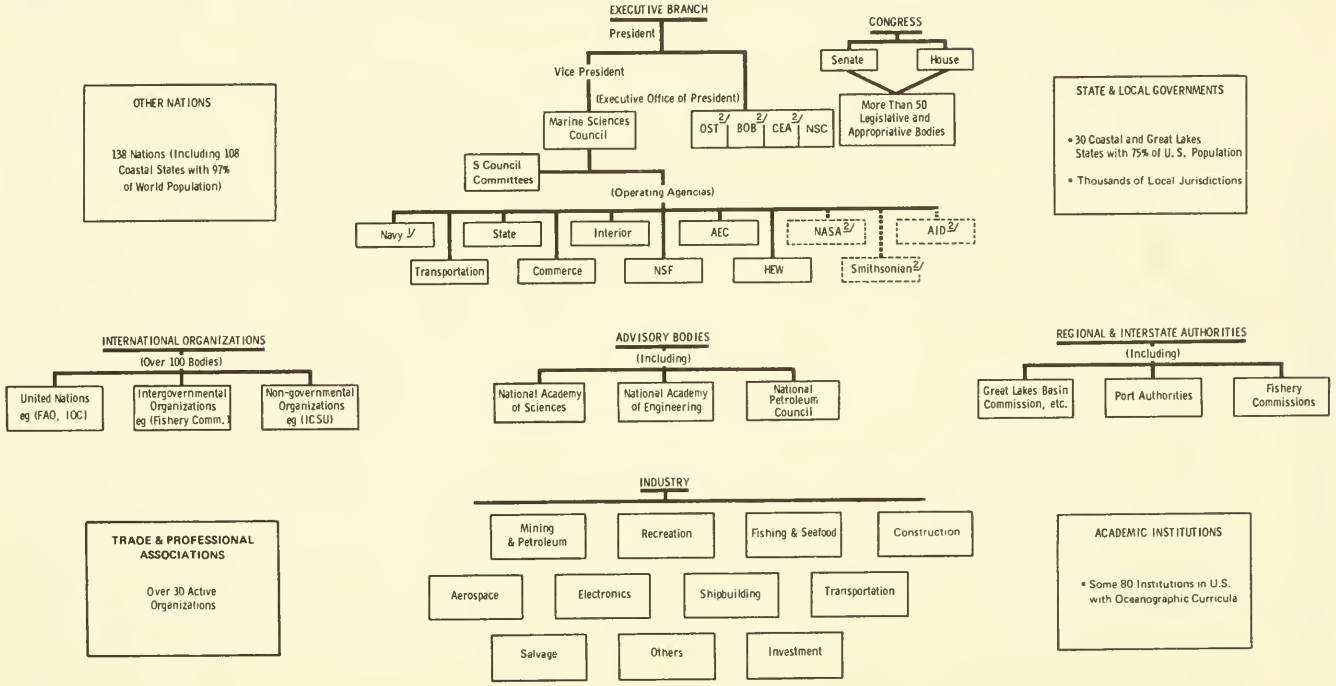
In January 1968 representatives of 12 leading mining firms were invited to present views on the appropriate role of Federal agencies in encouraging the development of marine minerals in relation to technology for delineating and extracting marine minerals and an administrative-legal-financial framework for encouraging offshore private investment. Also in January more than 40 senior representatives of government, industry, and our universities exchanged views on the International Decade of Ocean Exploration.

A March conference at the University of Washington, partially supported by the Council, assembled more than 250 representatives of all parts of the seafood industry (Chapter VI). In April, the Directors of non-Federal marine research laboratories exchanged views with the Vice President and senior government officials on programs such as the International Decade of Ocean Exploration, the Sea Grant Program, and Federal support of academic research. In October, representatives of the following organizations presented their views on national marine policies to Council and agency officials: National Petroleum Council, American Mining Congress, National Fisheries Institute, American Merchant Marine Institute, Aerospace Industries Association of America, Marine Technology Society, National Security Industrial Association, and National Federation of Independent Business.

In November, a symposium in Williamsburg, Va., organized by the Council's Committee on Multiple Use of the Coastal Zone provided a forum to gain the views of more than 60 representatives of State and local governments, as well as individual specialists, on steps for improving governmental mechanisms which will enhance use of the Coastal Zone. These views were carefully evaluated in preparing many of the Council recommendations included in Chapter IV, with particular attention to Federal incentives which will encourage the States to develop and carry out programs for rational use of the Coastal Zone in the national interest.

The 22 States fronting the Atlantic Ocean, Gulf of Mexico, and Pacific Ocean and the eight States bordering the Great Lakes have created numerous and varied State executive structures for policy and decision-making and administration of marine activities. These mechanisms include Governors' advisory councils and committees and State commissions, authorities, departments, divisions, bureaus, and boards. The bodies may have purely advisory

Figure XV–1—Participants in the Marine Sciences



1/ Represents all Agencies in Department of Defense

2/ Observers on Marine Sciences Council

functions or regulatory, enforcement, or management authority related to recreation, commercial fishing and living resources, waste disposal, nonliving resources, maritime commerce, and conservation. While authorities frequently overlap in individual States, most States usually vest commercial fishery and conservation responsibilities in single agencies and grant maritime commerce planning and regulatory powers to port authorities or commissions. Pollution control is becoming an increasing area of State concern.

These coastal States participate in a large number of interstate arrangements, compacts, and bodies. These interstate institutions deal largely with fisheries, commerce, transportation, water resources, conservation, and pollution to serve a coordination or communication function. While their impact is real, it is frequently restricted by staffing and budget limitations. At a November meeting in Miami devoted to Coastal Zone planning and management, representatives of 18 States adopted a Resolution calling for establishment of an organization of maritime States.

The close relationships between government agencies and the National Academy of Sciences and the National Academy of Engineering are reflected in a contract between the Marine Sciences Council and the Academies concerning the scientific and engineering aspects of the International Decade of Ocean Exploration as described in Chapter IX.

To assist in identifying and coordinating the many diverse marine activities being conducted by Federal and non-Federal institutions, the Marine Sciences Council has supported steps to improve information transfer within the marine community (Chapter XIII). Specific Council actions include: a comprehensive data management study, an inventory of Federal and non-Federal research, and discussions with information centers to urge that more of their products be tailored to the needs of marine scientists and program planners.

A number of non-governmental organizations continue to provide advice to the member agencies of the Council. The Departments of State and the Interior have actively sought the views of the extractive industry and many other private interests concerning the evolution of a legal regime for the seabed, an issue of particular industrial interest. Also, the maritime industry has been closely involved in the development of our domestic and international shipping policies.

Advice is broadly sought from all of the foregoing constituencies in order to assist in evaluation of Federal agency programs. Each year task groups of consultants are convened in mission-oriented panels, representing the spectrum of marine science interests, to receive agency presentations and then to provide to the Council a candid analysis of strengths and weaknesses, including recommendations as to further steps to meet statutory objectives.

A National Advocate for Marine Sciences

The Marine Sciences Act reflected Congressional concern over the need for high-level advocacy for the field. Notwithstanding the popularity that the field enjoys and the heightened popular interest in the scientific mysteries of the oceans, there had been no central advocate within the Federal family for examining and responding to the question of "What portion of the Nation's energy and wealth should be devoted to ocean endeavors?" Thus, in addition to its primary responsibility of assisting the President in carrying out the provisions of the Marine Sciences Act, the Council has served as an advocate—acting through its Chairman, its members, and its Executive Secretary, who in communications with members of Congress, speeches, public articles, communications to oceanographic institutions, and talks with foreign leaders have urged wider understanding of the relationship of the oceans to people and their concerns.

The Marine Sciences Act gave permanent responsibility to the President to advance this field. The Council was given only interim authority to advise and assist the President until June 30, 1969, so as not to inadvertently inhibit the Marine Sciences Commission in its analysis. Thus, in marine sciences, options for the future are completely open. Decisions may be required as to more permanent policy planning and coordinating machinery, requirements for a new Federal operating agency, and means whereby public and private interests may be blended and the necessary capital attracted to advance the Nation toward the long-range objectives.

"Knowledge and understanding of the oceans promise to assume greater and greater importance in the future. This is not a one-year program—or even a ten-year program. It is the first step in a continuing effort to acquire and apply the information about a part of our world that will ultimately determine conditions of life in the rest of the world."

—JOHN F. KENNEDY

Chapter XVI
LOOKING AHEAD

Man's uses of the oceans date back to primitive extraction of salt and fish and exploration by raft and sailing canoe. Now we are in the midst of significantly new advances in mastery of the sea. The future holds even greater promise because of expanding scientific discoveries about the natural world around us, and because of innovations afforded by 20th century marine technology. To take advantage of these opportunities, we must clearly identify benefits, enunciate objectives, and effectively mobilize requisite technical resources. But while ideas and plans are necessary, they are not sufficient. Also required are venture capital, both public and private, and involvement of our many concerned socio-economic-political institutions.

Earlier chapters of this Report cast Federal efforts in oceanic exploration and research in broad terms to show how policy and institutional factors promote uses of the sea to serve major goals of the Nation, and of society itself.

The time frame in which these programs and budgets were discussed however, has primarily been the present and the near-term future of FY 1970.

To complete the perspective, this brief concluding chapter sets forth the unfinished business which warrants attention on the Nation's agenda, in the longer term. These views emerge from issues that became more clearly illuminated during the past year, and from a realistic appraisal of an increasing range of options offered by the marine environment to meet public purposes. They are presented not only in terms of what is scientifically or

technically possible, but also what is socially or economically desirable, and finally, what is feasible in the context of considerations that go beyond marine science affairs.

While the responsibility for leadership must largely rest on the Federal Government, our ocean activities embrace the States, industry, the academic world and other nations and involve complex interrelationships and interdependencies among these participants. The subtitle of this report "A Year of Broadened Participation" reflects special efforts during the past year to develop a more viable partnership of all concerned interests.

These activities and institutions may be thought of as being in two classes: the first are knowledge-generating; the second are knowledge-consuming. Effective articulation between the two is obviously required to match needs and opportunities. Policy planning has focused on imperfect articulation between participants, to identify and where possible dissolve inadvertent impediments to the smooth application of marine discoveries.

Within the Federal Government, interaction between knowledge producers and knowledge consumers has operated most effectively in the case of the Navy. This agency has had the clearest and strongest requirements for marine environmental data and historically has been this country's major sponsor of marine research, both basic and applied. Our progress in civilian fields has largely stemmed from this naval research base. Today, the Navy still funds more than one-half of the Federal marine science program.

In the case of civilian uses of the sea, however, we have been far less effective in matching scientific and technological capabilities to our needs. The number and variety of participants, their frequent competition of interests, the need to introduce non-technical considerations of law, finance, and foreign relations, and the setting of priorities in a more public forum have been accompanied by new communication problems between science, technology, and marine affairs.

As a consequence, virtually all of the issues that follow are focused on strengthening the civilian component of marine affairs. They have been selected from a substantially larger set of issues for long-term developments in marine science affairs, and are set forth as questions:

1. How should marine related, civilian activities be organized in the Federal Government—and policy planning and coordination carried out for the President—to implement the mandate of P.L. 89–454 and to assure requisite leadership, meaningful priorities, and appropriate partnership with States, other nations, American industry, and science?

2. How may more effective use of coastal waters and land be achieved for public and private purposes—with due consideration for heightened State involvement, and improved Coastal Zone research capabilities—to foster prudent resource management?

3. What are the alternative legal arrangements dealing with the seabed boundaries of national sovereignty, and international disposition of rights

and benefits beyond national sovereignty that will preserve traditional concepts as to freedom of the seas; and what further steps will best serve the many diverse interests of the United States and the world community?

4. What longer-range steps are required in marine exploration and research to:
   a. implement the International Decade of Ocean Exploration;
   b. strengthen ocean environment observation and prediction capabilities;
   c. provide stable support for multi-purpose academic research institutions and develop them as national facilities;
   d. utilize research capabilities originally developed for other missions; and
   e. coordinate ocean and atmospheric science and services?

5. What additional steps should be taken to realize the potential of FPC in the War on Hunger—to translate technical potential into an economically and socially viable enterprise?

6. What legislative steps are needed to strengthen the domestic fishing industry?

7. How may support of a balanced, civilian marine technology be undertaken as a specific mode of government assistance to an emerging marine industry, particularly in those research and development areas where investment involves high initial cost or long deferred returns on investments?

8. What is the role of the U.S. flag merchant marine in contributing to national security and economic development, and what steps are needed to strengthen this element of a maritime presence?

In posing these questions, we should not lose sight of the great number of marine science issues that have been dealt with over the past three years and the goals and milestones set forth in this and two prior Reports of the President. Their full achievement has necessarily been limited by economic constraints that affected all components of the Federal budget because of the extraordinary demands of the Vietnam conflict and required deferment of many otherwise meritorious programs.

Collectively these short-run and longer-run issues concern the stake that this Nation—and the world—has in the sea.

Toward better comprehension of the portent for the future, the President appointed on January 9, 1967, the public advisory Commission on Marine Science, Engineering, and Resources provided for in P.L. 89–454, with Dr. Julius Stratton designated Chairman. This Commission has been at work for two years, and their comprehensive report was released on January 11, 1969. While their findings and recommendations could not be considered in detail by this Administration, they were deemed to warrant the most serious attention by the next Administration, by the Congress, and by interested public and private bodies.

APPENDICES

APPENDIX A—FEDERAL MARINE SCIENCE PROGRAM, FISCAL YEARS 1968, 1969, AND 1970

Appendix A–1—Total Federal Marine Science Program[a] by Major Purpose—Summary and Detail by Sub-Purpose and Agency

Summary

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
1. International Cooperation and Collaboration	9.6	9.5	11.7
2. National Security	119.9	128.1	143.0
3. Fishery Development and Seafood Technology	40.1	43.8	44.5
4. Transportation	11.1	10.6	18.6
5. Development of the Coastal Zone	27.6	29.5	29.6
6. Health	5.3	5.4	5.3
7. Non-Living Resources	7.3	8.0	8.6
8. Oceanographic Research[b]	78.1	[c]93.9	93.5
9. Education	7.0	7.5	9.2
10. Environmental Observation and Prediction	28.8	31.6	32.1
11. Ocean Exploration, Mapping, Charting, and Geodesy	75.7	83.0	99.1
12. General Purpose Ocean Engineering	19.2	18.3	29.5
13. National Data Centers	2.1	2.3	3.2
Total	431.8	471.5	528.0

[a] Many programs of the Departments of Defense, Commerce, Interior, and Transportation and other agencies closely related to marine science are not included.

[b] Research beneficial to more than one of the other major purpose areas.

[c] Includes $14.5 million for Coast Guard sub-polar oceanographic research ship. Funding for other ships is included in the relevant major purpose categories.

Appendix A–1—Total Federal Marine Science Program by Major Purpose—Summary and Detail by Sub-Purpose and Agency—Continued

Detail by Sub-Purpose and Agency

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
1. International Cooperation and Collaboration...	9.6	9.5	11.7
(a) Department of State.....	(6.6)	(7.0)	(7.1)
(1) Contributions to international organizations for marine science program activities...	4.6	4.9	4.9
(2) International fishery commissions (U.S. share).....	2.0	2.1	2.2
(b) Agency for International Development.	(3.0)	(2.5)	(4.6)
(1) Marine food resources for developing nations.....	3.0	2.5	4.6
2. National Security.....	119.9	128.1	143.0
(a) Department of Defense [a].....	(119.9)	(128.1)	(143.0)
(1) Problem oriented surveys for defense systems.....	19.5	24.1	28.3
(2) Marine science and technology in support of specific defense systems.....	29.9	34.0	35.3
(3) Undersea search, rescue, recovery, and man-in-the-sea.	68.7	68.6	77.4
(4) Navy Instrumentation Center.	1.2	1.2	1.8
(5) Capital investment for ship construction.....	0.0	0.0	0.0
(6) Marine science in support of "safeguards" for the Limited Nuclear Test Ban Treaty of 1963.....	0.6	0.2	0.2
3. Fishery Development and Seafood Technology.	40.1	43.8	44.5
(a) Department of the Interior.....	(40.1)	(43.8)	(44.5)
(1) Fishery resources assessment, development, and management.....	31.0	33.5	33.4
(2) Technical and economic assistance to the commercial fishing industry.....	7.9	7.8	8.2
(3) Fish protein concentrate.....	1.2	2.5	2.9

See footnotes at end of table.

Appendix A–1—Total Federal Marine Science Program by Major Purpose—Summary and Detail by Sub-Purpose and Agency—Continued

Detail by Sub-Purpose and Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
4. Transportation	11. 1	10. 6	18. 6
(a) Department of Commerce	(6. 8)	(4. 3)	(10. 1)
(1) Reduction of shipbuilding and port costs	0. 6	0. 0	0. 4
(2) Reduction of ship operating costs	1. 6	1. 6	2. 7
(3) Advanced ships and systems	3. 6	1. 6	5. 8
(4) Ship design	1. 0	1. 1	1. 2
(b) Department of Defense	(2. 9)	(2. 7)	(2. 9)
(1) Channel and harbor development	2. 9	2. 7	2. 9
(c) Department of Transportation	(1. 4)	(3. 6)	(5. 6)
(1) Search and rescue	0. 3	0. 6	0. 7
(2) Aids to navigation	0. 7	0. 6	1. 5
(3) Merchant marine safety	0. 3	0. 8	0. 8
(4) Oceanography, meteorology, and polar operations [b]	0. 1	0. 5	0. 6
(5) Marine law enforcement [b]	0. 0	1. 1	2. 0
5. Development and Conservation of the Coastal Zone	27. 6	29. 5	29. 6
(a) Shore stabilization and protection	(1. 5)	(1. 5)	(1. 5)
(1) Department of Defense			
a. Beach erosion control and hurricane storm surge protection	1. 5	1. 5	1. 5
(b) Marine pollution management	(7. 4)	(9. 0)	(9. 0)
(1) Department of Defense	((1. 7))	((2. 2))	((1. 6))
a. Pollution and flushing of bays, estuaries, and the Great Lakes	1. 7	2. 2	1. 6
(2) Department of the Interior	((5. 7))	((6. 8))	((7. 4))
a. Water quality enhancement	5. 7	6. 8	7. 4
(c) Recreation and conservation	(18. 7)	(19. 0)	(19. 1)
(1) Department of Defense	((1. 5))	((1. 5))	((1. 4))
a. Recreation beaches and small craft harbors	1. 5	1. 5	1. 4

See footnotes at end of table.

Appendix A–1—Total Federal Marine Science Program by Major Purpose—Summary and Detail by Sub-Purpose and Agency—Continued

Detail by Sub-Purpose and Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
5. Development and Conservation of the Coastal Zone—Continued			
(c) Recreation and conservation			
(2) Department of the Interior...	((17. 1))	((17. 3))	((17. 4))
a. Planning for acquisition of marine based recreational areas...	0. 1	0. 1	0. 1
b. Development of marine areas for recreation.....	12. 0	11. 3	11. 4
c. Conservation of marine locales, gamefish and wildlife....	5. 0	5. 9	5. 9
(3) Department of Transportation.....	((0. 1))	((0. 2))	((0. 3))
a. Search and rescue....	0. 1	0. 2	0. 3
6. Health.....	5. 3	5. 4	5. 3
(a) Department of Health, Education, and Welfare.....	(5. 3)	(5. 4)	(5. 3)
(1) Nutritional and health aspects of marine foods.....	1. 6	1. 7	1. 8
(2) Marine bacterial toxins and pharmaceuticals.....	0. 6	0. 7	0. 6
(3) Use of marine life in biomedical research.....	2. 4	2. 4	2. 4
(4) Health problems related to marine pollution.....	0. 7	0. 6	0. 5
7. Non-Living Resources.....	7. 3	8. 0	8. 6
(a) Department of the Interior.....	(7. 3)	(8. 0)	(8. 6)
(1) Geologic investigations and resource appraisal.....	2. 8	2. 9	3. 4
(2) Mining research.....	1. 3	1. 5	0. 9
(3) Marine sources and interrelationships for supply of fresh water.....	2. 3	2. 5	3. 0
(4) Leasing and management of mineral resources.....	0. 9	1. 1	1. 3

See footnotes at end of table.

Appendix A–1—Total Federal Marine Science Program by Major Purpose—Summary and Detail by Sub-Purpose and Agency—Continued

Detail by Sub-Purpose and Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
8. Oceanographic Research	78. 1	93. 9	93. 5
(a) Department of Defense	30. 5	35. 4	39. 8
(b) Department of Commerce	3. 4	3. 7	3. 7
(c) National Science Foundation	33. 8	30. 7	39. 6
(d) Department of Transportation	3. 8	17. 4	3. 3
(e) Smithsonian Institution[c]	1. 6	1. 6	1. 6
(f) Atomic Energy Commission	5. 0	5. 1	5. 5
9. Education	7. 0	7. 5	9. 2
(a) Department of Defense	1. 4	1. 6	1. 8
(b) Department of Commerce	0. 1	0. 1	0. 1
(c) Department of the Interior	0. 1	0. 1	0. 1
(d) National Science Foundation	4. 0	4. 0	5. 5
(e) Department of Health, Education, and Welfare	1. 2	1. 5	1. 5
(f) Department of Transportation	0. 2	0. 2	0. 2
10. Environmental Observation and Prediction	28. 8	31. 6	32. 1
(a) Department of Defense	10. 5	11. 6	11. 5
(b) Department of Commerce	6. 2	5. 8	6. 0
(c) Atomic Energy Commission	0. 9	0. 8	0. 6
(d) Department of Transportation	9. 7	12. 0	12. 7
(e) National Aeronautics and Space Administration	1. 5	1. 4	1. 3
11. Ocean Exploration, Mapping, Charting, and Geodesy	75. 7	83. 0	99. 1
(a) Department of Defense	58. 6	63. 5	78. 5
(b) Department of Commerce	16. 8	19. 1	20. 2
(c) National Aeronautics and Space Administration	0. 3	0. 4	0. 4

See footnotes at end of table.

Appendix A–1—Total Federal Marine Science Program by Major Purpose—Summary and Detail by Sub-Purpose and Agency—Continued

Detailed by Sub-Purpose and Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
12. General Purpose Ocean Engineering	19.2	18.3	29.5
(a) Department of Defense			
(1) Deep ocean technology	11.2	13.2	14.4
(b) Atomic Energy Commission			
(1) Nuclear power	7.9	4.5	5.3
(c) Department of Transportation			
(1) Data buoy systems	0.1	0.6	9.8
13. National Data Centers	2.1	2.3	3.2
(a) National Oceanographic Data Center[d]	1.6	1.7	2.5
(b) Smithsonian Oceanographic Sorting Center	0.3	0.3	0.4
(c) Great Lakes Data Center	0.2	0.2	0.2
(d) National Weather Records Center	0.0	0.1	0.1

[a] All Department of Defense funds (except Corps of Engineers) relate primarily to National Security although for this special analysis some funds have been allocated to other purpose areas.

[b] New program category. Item 4(c)4 includes the International Ice Patrol and Item 4(c)5 contains Pollution Detection and Control, categories utilized in last year's report.

[c] Appropriated Excess Foreign Currency Funds are also used to support marine research. (See Appendix A–7.)

[d] Includes National Science Foundation support for World Data Center A of $60,000, $75,000, and $75,000, respectively, for the three years.

Appendix A–2—Total Federal Marine Science Program[a] by Department and Independent Agency

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
Department of Defense	240.6	262.3	297.9
Department of the Interior	70.5	76.2	78.2
National Science Foundation	38.1	35.0	45.4
Department of Commerce	33.6	33.4	40.6
Department of Transportation	15.4	34.1	32.3
Atomic Energy Commission	13.8	10.4	11.4
Department of Health, Education, and Welfare	6.5	6.9	6.8
Department of State	6.6	7.0	7.1
Agency for International Development	3.0	2.5	4.6
Smithsonian Institution[b]	1.9	1.9	2.0
National Aeronautics and Space Administration	1.8	1.8	1.7
Total	431.8	471.5	528.0

[a] Many programs of the Departments of Defense, Commerce, Interior, and Transportation, and other agencies, closely related to marine science are not included.

[b] Excess Foreign Currency Funds are not included. See Appendix A–7.

Appendix A–3—Total Federal Marine Science Program by Function—Summary and Detail by Agency

Summary

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
Research and Development	245. 4	248. 3	297. 9
(a) Research (basic and applied)	116. 4	126. 7	150. 6
(b) Development of new equipment and technology	129. 0	121. 6	147. 3
Investment	55. 5	77. 8	70. 1
(a) Ships	7. 6	15. 1	2. 3
(b) Major equipment	29. 3	42. 4	47. 5
(c) Shore facilities	13. 9	15. 5	13. 3
(d) Other	4. 7	4. 8	7. 0
Operations	130. 9	145. 4	160. 0
(a) Surveys	106. 0	118. 7	130. 9
(b) Services	18. 4	19. 5	21. 4
(c) Other	6. 5	7. 2	7. 8
Total	431. 8	471. 5	528. 0

Detail by Agency

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
A. RESEARCH AND DEVELOPMENT			
Total	245. 4	248. 4	297. 9
1. Department of Defense	132. 8	133. 0	155. 9
(a) Department of the Navy	(123. 8)	(123. 9)	(147. 4)
(1) Research	30. 5	35. 4	36. 8
Regular program	(28. 1)	(32. 4)	(33. 3)
(Research ship operating costs)	((6. 1))	((6. 7))	((7. 8))
Institutional development program	(2. 4)	(3. 0)	(3. 5)
(2) Development of new equipment and technology	93. 3	88. 5	110. 6
(Ship operating costs)	(6. 9)	(8. 1)	(8. 8)

Appendix A-3—Total Federal Marine Science Program by Function—Continued

Detail by Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
A. RESEARCH AND DEVELOPMENT—Continued			
1. Department of Defense—Continued			
(b) Department of the Army	(8.4)	(8.7)	(8.3)
(1) Research	3.4	3.5	3.4
(2) Development of new equipment and technology	5.0	5.2	4.9
(c) Advanced Research Projects Agency	(0.6)	(0.4)	(0.2)
(1) Research	0.2	0.4	0.2
(2) Development of new equipment and technology	0.4	0.0	0.0
2. Department of Commerce	11.4	9.5	14.8
(a) Environmental Science Services Administration	(4.7)	(5.2)	(5.2)
(1) Research	3.6	3.8	4.0
(2) Development of new equipment and technology	1.1	1.4	1.2
(b) Maritime Administration	(6.7)	(4.3)	(9.6)
(1) Research	2.4	1.7	5.4
(2) Development of new equipment and technology	4.3	2.6	4.2
3. Department of the Interior	34.2	38.2	38.0
(a) Bureau of Commercial Fisheries	(24.9)	(27.8)	(27.1)
(1) Research	17.0	18.9	18.3
(Research ship operating costs)	(2.5)	(2.8)	(3.0)
(2) Development of new equipment and technology	7.9	8.9	8.9
(b) Geological Survey	(2.9)	(2.8)	(3.1)
(1) Research	2.9	2.8	3.1
(Research ship operating (costs)	(0.2)	(0.2)	(0.2)
(2) Development of new equipment and technology	0.0	0.0	0.0
(c) Office of Saline Water	(1.9)	(1.9)	(2.6)
(1) Research	0.6	0.6	0.8
(2) Development of new equipment and technology	1.3	1.3	1.8

Appendix A–3—Total Federal Marine Science Program by Function—Continued

Detail by Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
A. RESEARCH AND DEVELOPMENT—Continued			
3. Department of the Interior—Continued			
(d) Bureau of Sport Fisheries and Wildlife	(1.6)	(1.7)	(1.8)
(1) Research	1.6	1.7	1.8
(2) Development of new equipment and technology	0.0	0.0	0.0
(e) Bureau of Mines	(0.9)	(1.1)	(0.6)
(1) Research	0.4	0.5	0.3
(Research ship operating costs)	(0.3)	(0.4)	(0.2)
(2) Development of new equipment and technology	0.5	0.6	0.3
(f) Federal Water Pollution Control Administration	(2.0)	(2.9)	(2.8)
(1) Research	2.0	2.9	2.8
(2) Development of new equipment and technology	0.0	0.0	0.0
4. National Science Foundation	33.1	33.3	42.0
(1) Research	33.1	33.3	42.0
(Research ship operating costs)	(8.6)	(8.6)	(8.8)
5. Atomic Energy Commission	13.8	10.4	11.4
(1) Research	5.9	5.9	6.1
(Research ship operating costs)	(0.3)	(0.3)	(0.3)
(2) Development of new equipment and technology	7.9	4.5	5.3
6. Department of Health, Education, and Welfare	6.5	6.9	6.8
(a) Consumer Protection and Environmental Health Services	(2.7)	(2.8)	(2.7)
(1) Research	2.7	2.8	2.7
(b) National Institutes of Health	(2.6)	(2.6)	(2.6)
(1) Research	2.6	2.6	2.6
(c) Office of Education	(1.2)	(1.5)	(1.5)
(1) Research	1.2	1.5	1.5

Appendix A-3—Total Federal Marine Science Program by Function—Continued

Detail by Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
A. RESEARCH AND DEVELOPMENT—Continued			
7. Department of Transportation	3.6	6.7	18.6
(1) Research	2.9	5.1	15.5
(Research ship operating costs)	(2.2)	(2.7)	(3.2)
(2) Development of new equipment and technology	0.7	1.6	3.1
8. Smithsonian Institution	1.6	1.6	1.6
(1) Research	1.6	1.6	1.6
9. Department of State	6.6	7.0	7.1
(1) Development of new equipment and technology	6.6	7.0	7.1
10. National Aeronautics and Space Administration	1.8	1.8	1.7
(1) Research	1.8	1.8	1.7
B. INVESTMENT			
Total	55.5	77.8	70.1
1. Department of Defense	32.6	48.2	49.4
(a) Department of the Navy	(32.3)	(47.9)	(49.2)
(1) Ships (new construction of surface ships)	4.7	0.0	0.0
(2) Major equipment	25.9	40.9	45.4
(3) Shore facilities	1.7	7.0	3.8
(b) Department of the Army	(0.3)	(0.3)	(0.2)
(1) Shore facilities	0.3	0.3	0.2
2. Department of Commerce	2.0	0.9	1.1
(a) Environmental Science Services Administration	(1.9)	(0.9)	(0.6)
(1) Ships	0.0	0.0	0.0
(2) Shore facilities	0.2	0.0	0.0
(3) Major equipment	1.7	0.9	0.6
(b) Maritime Administration	(0.1)	(0.0)	(0.5)
(1) Shore facilities	0.1	0.0	0.5

Appendix A–3—Total Federal Marine Science Program by Function—Continued

Detail by Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
B. INVESTMENT—Continued			
3. Department of the Interior	10.3	9.7	10.4
(a) Bureau of Commercial Fisheries	(2.4)	(2.1)	(3.2)
(1) Ships	0.5	0.1	0.0
(2) Shore facilities	1.9	2.0	3.2
(3) Major equipment	0.0	0.0	0.0
(b) Geological Survey	(0.4)	(0.4)	(0.2)
(1) Shore facilities	0.2	0.2	0.1
(2) Major equipment	0.2	0.2	0.1
(c) Bureau of Sport Fisheries and Wildlife	(2.1)	(2.9)	(2.7)
(1) Shore facilities	0.4	0.6	0.3
(2) Major equipment	0.0	0.0	0.0
(3) Other	1.7	2.3	2.4
(d) Bureau of Mines	(0.4)	(0.4)	(0.3)
(1) Ships	0.2	0.2	0.0
(2) Shore facilities	0.1	0.1	0.2
(3) Major equipment	0.1	0.1	0.1
(e) Bureau of Outdoor Recreation	(5.0)	(3.9)	(4.0)
(1) Shore facilities	5.0	3.9	4.0
4. National Science Foundation	4.7	1.4	3.0
(1) Ships	0.7	0.0	2.0
(2) Shore facilities	4.0	1.4	1.0
5. Department of Transportation	2.9	15.1	1.6
(a) Coast Guard	(2.9)	(15.1)	(1.6)
(1) Ships	1.5	14.8	0.3
(2) Major equipment	1.4	0.3	1.3
6. Agency for International Development	3.0	2.5	4.6
(1) Other	3.0	2.5	4.6

Appendix A-3—Total Federal Marine Science Program by Function—Continued

Detail by Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
C. OPERATIONS			
Total	130. 9	145. 4	160. 0
1. Department of Defense	75. 2	81. 1	92. 6
(a) Department of the Navy	(75. 0)	(80. 9)	(92. 4)
(1) Surveys	70. 2	75. 9	86. 6
(Survey ship operating costs)	((24. 1))	((22. 3))	((24. 3))
(2) Services	3. 4	3. 4	4. 1
(3) Other (Education)	1. 4	1. 6	1. 8
(b) Department of the Army	(0. 2)	(0. 2)	(0. 2)
(1) Services	0. 2	0. 2	0. 2
2. Department of Commerce	20. 2	23. 1	24. 7
(a) Environmental Science Services Administration	(20. 2)	(23. 1)	(24. 7)
(1) Surveys	19. 9	22. 7	24. 3
(Survey ship operating costs)	((6. 6))	((7. 9))	((8. 6))
(2) Services	0. 3	0. 4	0. 4
3. Department of the Interior	26. 0	28. 3	29. 8
(a) Bureau of Commercial Fisheries	(13. 7)	(14. 8)	(15. 1)
(1) Surveys	6. 0	6. 6	6. 7
(Survey ship operating costs)	((1. 2))	((1. 1))	((1. 3))
(2) Services	7. 7	8. 2	8. 4
(Service ship operating costs)	((0. 3))	((0. 3))	((0. 3))
(b) Geological Survey	(0. 8)	(1. 1)	(1. 4)
(1) Other	0. 8	1. 1	1. 4
(c) Bureau of Sport Fisheries and Wildlife	(4. 7)	(5. 0)	(4. 9)
(1) Surveys	0. 4	0. 7	0. 6
(2) Services	0. 1	0. 1	0. 1
(3) Other	4. 2	4. 2	4. 2
(d) Federal Water Pollution Control Administration	(2. 9)	(3. 3)	(3. 9)
(1) Surveys	0. 8	0. 9	1. 1
(2) Services	2. 1	2. 4	2. 8
(e) Bureau of Land Management	(0. 2)	(0. 3)	(0. 5)
(1) Services	0 2	0. 3	0. 5
(f) National Park Service	(3. 7)	(3. 8)	(4. 0)
(1) Services	3. 7	3. 8	4. 0

Appendix A–3—Total Federal Marine Science Program by Function—Continued

Detail by Agency—Continued

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
C. OPERATIONS—Continued			
4. National Science Foundation	0. 3	0. 3	0. 4
(1) Services	0. 3	0. 3	0. 4
5. Department of Transportation	8. 9	12. 3	12. 1
(a) Coast Guard	(8. 9)	(12. 3)	(12. 1)
(1) Surveys	8. 7	11. 9	11. 6
(Survey ship operating costs)	((7. 8))	((10. 7))	((10. 7))
(2) Services	0. 1	0. 1	0. 1
(3) Other Operations	0. 1	0. 3	0. 4
6. Smithsonian Institution	0. 3	0. 3	0. 4
(1) Services	0. 3	0. 3	0. 4
7. Atomic Energy Commission:			
(1) Services	(a)	(a)	(a)

[a] Less than $50,000.

Appendix A–4—Special Analysis: U.S. Continental Shelves (Including Trust Territories)

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
Smithsonian Institution	0. 1	0. 1	0. 1
Department of Commerce	15. 0	16. 0	16. 6
Atomic Energy Commission	2. 9	3. 0	2. 9
Department of Transportation	0. 1	0. 1	0. 1
National Science Foundation	0. 5	1. 0	1. 0
Department of the Interior	30. 5	26. 0	27. 7
1. Bureau of Commercial Fisheries	(18. 5)	(17. 0)	(17. 4)
2. Geological Survey	(3. 4)	(3. 6)	(4. 1)
3. Bureau of Sport Fisheries and Wildlife	(0. 9)	(0. 9)	(0. 8)
4. Bureau of Mines	(1. 1)	(1. 2)	(0. 7)
5. Bureau of Land Management	(0. 2)	(0. 3)	(0. 5)
6. Office of Saline Water	(0. 7)	(0. 8)	(1. 1)
7. National Park Service	(5. 7)	(2. 2)	(3. 1)
Department of Defense	6. 7	8. 1	8. 4
1. Department of the Army	(3. 1)	(3. 2)	(3. 0)
2. Department of the Navy	(3. 6)	(4. 9)	(5. 4)
Total	55. 8	54. 3	56. 8

Appendix A–5—Special Analysis: The Great Lakes

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
Department of Commerce	0. 1	0. 1	0. 1
Department of Transportation	0. 1	0. 1	0. 1
Department of State	1. 0	1. 0	1. 1
National Science Foundation	0. 2	0. 7	0. 7
Department of the Interior	4. 9	4. 8	6. 0
1. Bureau of Commercial Fisheries	(2. 2)	(2. 6)	(2. 6)
2. Bureau of Sport Fisheries and Wildlife	(2. 2)	(1. 6)	(1. 6)
3. National Park Service	(0. 5)	(0. 6)	(1. 8)
Department of Defense	3. 7	3. 8	3. 6
1. Department of the Army	(3. 6)	(3. 7)	(3. 5)
2. Department of the Navy	(0. 1)	(0. 1)	(0. 1)
Total	10. 0	10. 5	11. 6

Appendix A–6—Special Analysis: Estuaries

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
Smithsonian Institution	0.1	0.1	0.1
Department of Commerce	0.6	0.6	0.7
Atomic Energy Commission	0.4	0.4	0.4
Department of Transportation	(a)	(a)	(a)
National Science Foundation	0.6	1.0	1.0
Department of the Interior	20.8	22.3	24.0
1. Bureau of Commercial Fisheries	(7.8)	(7.1)	(7.1)
2. Geological Survey	(0.6)	(0.6)	(0.5)
3. Bureau of Sport Fisheries and Wildlife	(5.3)	(7.1)	(7.0)
4. Federal Water Pollution Control Administration	(4.9)	(6.2)	(6.7)
5. Office of Saline Water	(0.7)	(0.7)	(0.8)
6. National Park Service	(1.5)	(0.6)	(1.9)
Department of Defense	4.0	4.4	4.4
1. Department of the Army	(2.2)	(2.3)	(2.2)
2. Department of the Navy	(1.8)	(2.1)	(2.2)
Total	26.5	28.8	30.6

[a] Less than $50,000.

Appendix A–7—Special Analysis: Excess Foreign Currency Programs[a]

(Millions of dollars)

	Estimated FY 1968	Estimated FY 1969	President's budget FY 1970
1. Fishery Development and Seafood Technology:			
(a) Department of the Interior:			
(1) Fishery resources assessment, development, and management	0.1	0.2	0.0
2. Oceanographic Research:			
(a) Department of Commerce (ESSA)	(b)	0.1	0.1
(b) Smithsonian Institution:			
(1) Specimen research	0.7	0.8	1.5
3. Data Centers:			
(a) Smithsonian Institution:			
(1) Service operations	0.2	0.2	0.3
Total	1.0	1.3	1.9

[a] Excess Foreign Currency funds reported herein are not included in any of the other funding tables.
[b] Less than $50,000.

APPENDIX B—FEDERAL LEGISLATION AND CONGRESSIONAL RESOLUTIONS RELATED TO MARINE SCIENCES

Appendix B-1—Selected Legislation of the 89th and 90th Congresses

Public Law 89–72 (July 9, 1965)—Federal Water Project Recreation Act, provided uniform policies with respect to recreation, fish, and wildlife benefits, and costs of federal multi-purpose water resources projects.

Public Law 89–80 (July 21, 1965)—Water Resources Planning Act, provided for coordinated planning of water and related land resources, through the establishment of a water resources council and river basin commissions, and provided funds to the states to increase state participation in such planning.

Public Law 89–99 (July 30, 1965)—Exempted oceanographic research vessels from application of certain inspection laws.

Public Law 89–234 (October 2, 1965)—Water Quality Act of 1965, established the Federal Water Pollution Control Administration, provided grants for research and development, increased grants for construction of sewage treatment works, and required establishment of water quality criteria.

Public Law 89–298 (October 27, 1965)—Omnibus rivers and harbors act which included a study of water utilization and control of Chesapeake Bay and construction of a large scale model for this purpose.

Public Law 89–302 (October 30, 1965)—Authorized use by the Secretary of the Interior of land at La Jolla, California, donated by the University of California, for a marine biological research laboratory.

Public Law 89–454 (June 17, 1966)—Marine Resources and Engineering Development Act of 1966, established a national policy to advance marine sciences and created a cabinet level Council and advisory Commission.

Public Law 89–658 (October 14, 1966)—Established a contiguous fishing zone beyond the territorial sea of the United States.

Public Law 89–670 (October 15, 1966)—Provided for a Department of Transportation which would include the Coast Guard.

Public Law 89–688 (October 15, 1966)—National Sea Grant College and Program Act of 1966, added a Title II to P.L. 89–454 authorizing grants to institutions to operate programs of applied research, training and education, and information dissemination; amended by P.L. 90–477, August 11, 1968.

Public Law 89–701 (November 2, 1966)—Authorized funds to determine practicable and economic means for the production of fish-protein concentrate which would include construction and leasing of experimental FPC plants.

Public Law 89–753 (November 3, 1966)—Clean Water Restoration Act of 1966, provided for Federal assistance to and cooperation with groups developing water quality control and pollution abatement programs and authorized a national estuarine pollution study.

Public Law 90–18 (May 19, 1967)—Provided for the participation of the Department of the Interior in the construction and operation of a large prototype desalting plant in southern California.

Public Law 90–137 (November 14, 1967)—Foreign Assistance Act of 1967, amended the 1961 Act to authorize, among others, a program to demonstrate the potential and encourage the use of fish and other protein concentrates as a practical means of reducing nutritional deficiencies in less-developed countries and areas. The President was urged to use at least $2,500,000 of the total funds authorized by the Act for this particular program.

Appendix B–1—Selected Legislation of the 89th and 90th Congresses—Con.

Public Law 90–205 (December 15, 1967)—Amended the Act of October 4, 1961, relating to the acquisition of wetlands for conservation of migratory waterfowl, to extend for an additional eight years the period during which funds may be appropriated under that Act, and for other purposes.

Public Law 90–242 (January 2, 1968)—Amended the Marine Resources and Engineering Development Act of 1966 to extend the time for the Commission to render its report to January 9, 1969 and authorize the Council until June 30, 1969.

Public Law 90–268 (March 16, 1968)—Amended the Merchant Marine Act of 1936 to provide for study of means to encourage development and implementation of new concepts for the carriage of cargo, including containerization.

Public Law 90–401 (July 15, 1968)—Amended the Land and Water Conservation Act of 1965 to authorize funding at $200 million a year through FY 1973 and use of Outer Continental Shelf revenues to make up difference between actual appropriation and $200 million.

Public Law 90–419 (July 24, 1968)—Created an eight-state Great Lakes Compact to develop, use, and conserve the water resources of that basin, and a Great Lakes Basin Commission.

Public Law 90–427 (July 26, 1968)—Prohibited foreign vessels from engaging in fisheries, or in fishing fleet support activities, in the territorial seas of the U.S. and its territories except as provided by international agreement.

Public Law 90–454 (August 3, 1968)—Authorized the Secretary of the Interior, in cooperation with the States, to conduct an inventory and study of the Nation's estuaries and their natural resources.

Public Law 90–482 (August 12, 1968)—Amended the Fishermen's Protective Act of 1967 to guarantee owners of fishing vessels all costs incurred during a period of illegal seizure and detention of vessels including damages to boat and catch.

Public Law 90–483 (September 4, 1968)—Omnibus rivers and harbors act which included planning for surveys of erosion of the coasts of the United States, excluding the Great Lakes, disposal of drift and other harbor debris, and prevention of shore damage due to navigation projects.

Public Law 90–515 (September 26, 1968)—National Water Commission Act, established a National Water Commission to review present and future water problems, consider economic and social consequences of water resources developments, advise of matters referred to it by the President and the Water Resources Council, and to submit a final report in not for than 5 years.

Public Law 90–549 (October 4, 1968)—Amended PL 89–701 to reduce the number of experimental plants authorized for the development of fish protein concentrate to one plant to be provided either through construction or leasing and thus authorized sufficient funds for completion of one demonstration plant.

Appendix B–2—Marine Resources and Engineering Development Act of 1966

(Public Law 89–454, June 17, 1966)

AN ACT To provide for a comprehensive, long-range, and coordinated national program in marine science, to establish a National Council on Marine Resources and Engineering Development, and a Commission on Marine Science, Engineering and Resources, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Marine Resources and Engineering Development Act of 1966".

Appendix B–2—Marine Resources and Engineering Development Act of 1966—Continued

DECLARATION OF POLICY AND OBJECTIVES

SEC. 2. (a) It is hereby declared to be the policy of the United States to develop, encourage, and maintain a coordinated, comprehensive, and long-range national program in marine science for the benefit of mankind to assist in protection of health and property, enhancement of commerce, transportation, and national security, rehabilitation of our commercial fisheries, and increased utilization of these and other resources.

(b) The marine science activities of the United States should be conducted so as to contribute to the following objectives:

(1) The accelerated development of the resources of the marine environment.

(2) The expansion of human knowledge of the marine environment.

(3) The encouragement of private investment enterprise in exploration, technological development, marine commerce, and economic utilization of the resources of the marine environment.

(4) The preservation of the role of the United States as a leader in marine science and resource development.

(5) The advancement of education and training in marine science.

(6) The development and improvement of the capabilities, performance, use, and efficiency of vehicles, equipment, and instruments for use in exploration, research, surveys, the recovery of resources, and the transmission of energy in the marine environment.

(7) The effective utilization of the scientific and engineering resources of the Nation, with close cooperation among all interested agencies, public and private, in order to avoid unnecessary duplication of effort, facilities, and equipment, or waste.

(8) The cooperation by the United States with other nations and groups of nations and international organizations in marine science activities when such cooperation is in the national interest.

THE NATIONAL COUNCIL ON MARINE RESOURCES AND ENGINEERING DEVELOPMENT

SEC. 3. (a) There is hereby established, in the Executive Office of the President, the National Council on Marine Resources and Engineering Development (hereinafter called the "Council") which shall be composed of—

(1) The Vice President, who shall be Chairman of the Council.

(2) The Secretary of State.

(3) The Secretary of the Navy.

(4) The Secretary of the Interior.

(5) The Secretary of Commerce.

(6) The Chairman of the Atomic Energy Commission.

(7) The Director of the National Science Foundation.

(8) The Secretary of Health, Education, and Welfare.

(9) The Secretary of the Treasury.

(b) The President may name to the Council such other officers and officials as he deems advisable.

(c) The President shall from time to time designate one of the members of the Council to preside over meetings of the Council during the absence, disability, or unavailability of the Chairman.

(d) Each member of the Council, except those designated pursuant to subsection (b), may designate any officer of his department or agency appointed with the advice and consent of the Senate to serve on the Council as his alternate in his unavoidable absence.

Appendix B–2—Marine Resources and Engineering Development Act of 1966—Continued

(e) The Council may employ a staff to be headed by a civilian executive secretary who shall be appointed by the President and shall receive compensation at a rate established by the President at not to exceed that of level II of the Federal Executive Salary Schedule. The executive secretary, subject to the direction of the Council, is authorized to appoint and fix the compensation of such personnel, including not more than seven persons who may be appointed without regard to civil service laws or the Classification Act of 1949 and compensated at not to exceed the highest rate of grade 18 of the General Schedule of the Classification Act of 1949, as amended, as may be necessary to perform such duties as may be prescribed by the President.

(f) The provisions of this Act with respect to the Council shall expire one hundred and twenty days after the submission of the final report of the Commission pursuant to section 5(h).

RESPONSIBILITIES

SEC. 4. (a) In conformity with the provisions of section 2 of this Act, it shall be the duty of the President with the advice and assistance of the Council to—

(1) survey all significant marine science activities, including the policies, plans, programs, and accomplishments of all departments and agencies of the United States engaged in such activities;

(2) develop a comprehensive program of marine science activities, including, but not limited to, exploration, description and prediction of the marine environment, exploitation and conservation of the resources of the marine environment, marine engineering, studies of air-sea interaction, transmission of energy, and communications, to be conducted by departments and agencies of the United States, independently or in cooperation with such non-Federal organizations as States, institutions and industry;

(3) designate and fix responsibility for the conduct of the foregoing marine science activities by departments and agencies of the United States;

(4) insure cooperation and resolve differences arising among departments and agencies of the United States with respect to marine science activities under this Act, including differences as to whether a particular project is a marine science activity;

(5) undertake a comprehensive study, by contract or otherwise, of the legal problems arising out of the management, use, development, recovery, and control of the resources of the marine environment;

(6) establish long-range studies of the potential benefits to the United States economy, security, health, and welfare to be gained from marine resources, engineering, and science, and the costs involved in obtaining such benefits; and

(7) review annually all marine science activities conducted by departments and agencies of the United States in light of the policies, plans, programs, and priorities developed pursuant to this Act.

(b) In the planning and conduct of a coordinated Federal program the President and the Council shall utilize such staff, interagency, and non-Government advisory arrangements as they may find necessary and appropriate and shall consult with departments and agencies concerned with marine science activities and solicit the views of non-Federal organizations and individuals with capabilities in marine sciences.

COMMISSION ON MARINE SCIENCE, ENGINEERING, AND RESOURCES

SEC. 5. (a) The President shall establish a Commission on Marine Science, Engineering, and Resources (in this Act referred to as the "Commission"). The Commission shall be composed of fifteen members appointed by the President, including

Appendix B–2—Marine Resources and Engineering Development Act of 1966—Continued

individuals drawn from Federal and State governments, industry, universities, laboratories and other institutions engaged in marine scientific or technological pursuits, but not more than five members shall be from the Federal Government. In addition the Commission shall have four advisory members appointed by the President from among the Members of the Senate and the House of Representatives. Such advisory members shall not participate, except in an advisory capacity, in the formulation of the findings and recommendations of the Commission. The President shall select a Chairman and Vice Chairman from among such fifteen members. The Vice Chairman shall act as Chairman in the latter's absence.

(b) The Commission shall make a comprehensive investigation and study of all aspects of marine science in order to recommend an overall plan for an adequate national oceanographic program that will meet the present and future national needs. The Commission shall undertake a review of existing and planned marine science activities of the United States in order to assess their adequacy in meeting the objectives set forth under section 2(b), including but not limited to the following:

(1) Review the known and contemplated needs for natural resources from the marine environment to maintain our expanding national economy.

(2) Review the surveys, applied research programs, and ocean engineering projects required to obtain the needed resources from the marine environment.

(3) Review the existing national research programs to insure realistic and adequate support for basic oceanographic research that will enhance human welfare and scientific knowledge.

(4) Review the existing oceanographic and ocean engineering programs, including education and technical training, to determine which programs are required to advance our national oceanographic competence and stature and which are not adequately supported.

(5) Analyze the findings of the above reviews, including the economic factors involved, and recommend an adequate national marine science program that will meet the present and future national needs without unnecessary duplication of effort.

(6) Recommend a Governmental organizational plan with estimated cost.

(c) Members of the Commission appointed from outside the Government shall each receive $100 per diem when engaged in the actual performance of duties of the Commission and reimbursement of travel expenses, including per diem in lieu of subsistence, as authorized in section 5 of the Administrative Expenses Act of 1946, as amended (5 U.S.C. 73b–2), for persons employed intermittently. Members of the Commission appointed from within the Government shall serve without additional compensation to that received for their services to the Government but shall be reimbursed for travel expenses, including per diem in lieu of subsistence, as authorized in the Act of June 9, 1949, as amended (5 U.S.C. 835–842).

(d) The Commission shall appoint and fix the compensation of such personnel as it deems advisable in accordance with the civil service laws and the Classification Act of 1949, as amended. In addition, the Commission may secure temporary and intermittent services to the same extent as is authorized for the departments by section 15 of the Administrative Expenses Act of 1946 (60 Stat. 810) but at rates not to exceed $100 per diem for individuals.

(e) The Chairman of the Commission shall be responsible for (1) the assignment of duties and responsibilities among such personnel and their continuing supervision, and (2) the use and expenditures of funds available to the Commission. In carrying out the provisions of this subsection, the Chairman shall be governed by the general policies of the Commission with respect to the work to be accomplished by it and the timing thereof.

Appendix B–2—Marine Resources and Engineering Development Act of 1966—Continued

(f) Financial and administrative services (including those related to budgeting, accounting, financial reporting, personnel, and procurement) may be provided the Commission by the General Services Administration, for which payment shall be made in advance, or by reimbursement from funds of the Commission in such amounts as may be agreed upon by the Chairman of the Commission and the Administrator of General Services: *Provided,* That the regulations of the General Services Administration for the collection of indebtedness of personnel resulting from erroneous payments (5 U.S.C. 46d) shall apply to the collection of erroneous payments made to or on behalf of a Commission employee, and regulations of said Administrator for the administrative control of funds (31 U.S.C. 665(g)) shall apply to appropriations of the Commission: *And provided further,* That the Commission shall not be required to prescribe such regulations.

(g) The Commission is authorized to secure directly from any executive department, agency, or independent instrumentality of the Government any information it deems necessary to carry out its functions under this Act; and each such department, agency, and instrumentality is authorized to cooperate with the Commission and, to the extent permitted by law, to furnish such information to the Commission, upon request made by the Chairman.

(h) The Commission shall submit to the President, via the Council, and to the Congress not later than eighteen months after the establishment of the Commission as provided in subsection (a) of this section, a final report of its findings and recommendations. The Commission shall cease to exist thirty days after it has submitted its final report.

INTERNATIONAL COOPERATION

SEC. 6. The Council, under the foreign policy guidance of the President and as he may request, shall coordinate a program of international cooperation in work done pursuant to this Act, pursuant to agreements made by the President with the advice and consent of the Senate.

REPORTS

SEC. 7. (a) The President shall transmit to the Congress in January of each year a report, which shall include (1) a comprehensive description of the activities and the accomplishments of all agencies and departments of the United States in the field of marine science during the preceding fiscal year, and (2) an evaluation of such activities and accomplishments in terms of the objectives set forth pursuant to this Act.

(b) Reports made under this section shall contain such recommendations for legislation as the President may consider necessary or desirable for the attainment of the objectives of this Act, and shall contain an estimate of funding requirements of each agency and department of the United States for marine science activities during the succeeding fiscal year.

DEFINITIONS

SEC. 8. For the purposes of this Act the term "marine science" shall be deemed to apply to oceanographic and scientific endeavors and disciplines, and engineering and technology in and with relation to the marine environment; and the term "marine environment" shall be deemed to include (a) the oceans, (b) the Continental Shelf of the United States, (c) the Great Lakes, (d) seabed and subsoil of the submarine areas adjacent to the coasts of the United States to the depth of two hundred meters, or beyond that limit, to where the depths of the superjacent waters admit of the exploitation of the natural resources of such areas, (e) the seabed and subsoil of

Appendix B–2—Marine Resources and Engineering Development Act of 1966—Continued

similar submarine areas adjacent to the coasts of islands which comprise United States territory, and (f) the resources thereof.

AUTHORIZATION

SEC. 9. There are hereby authorized to be appropriated such sums as may be necessary to carry out this Act, but sums appropriated for any one fiscal year shall not exceed $1,500,000.

AMENDMENT

(Public Law 90–242, January 2, 1968)

AN ACT To amend the Marine Resources and Engineering Development Act of 1966, as amended, to extend the period of time within which the Commission on Marine Science, Engineering, and Resources is to submit its final report and to provide for a fixed expiration date for the National Council on Marine Resources and Engineering Development.

Be it enacted by the Senate and House of Representatives of the United States of American in Congress assembled, That the Marine Resources and Engineering Development Act of 1966 is amended as follows:

Subparagraph (h) of section 5 is amended by striking out "eighteen" and inserting "twenty-four" in lieu thereof.

SEC. 2. Subparagraph (f) of section 3 is amended by striking out "one hundred and twenty days after the submission of the final report of the Commission pursuant to section 5(h)." and inserting in lieu thereof " 'on June 30, 1969.' ".

Appendix B–3—National Sea Grant College and Program Act of 1966

(Public Law 89–688, October 15, 1966)

AN ACT To amend the Marine Resources and Engineering Development Act of 1966 to authorize the establishment and operation of sea grant colleges and programs by initiating and supporting programs of education and research in the various fields relating to the development of marine resources, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Marine Resources and Engineering Development Act of 1966 is amended by adding at the end thereof the following new title:

"TITLE II—SEA GRANT COLLEGES AND PROGRAMS

"SHORT TITLE

"SEC. 201. This title may be cited as the 'National Sea Grant College and Program Act of 1966'.

"DECLARATION OF PURPOSE

"SEC. 202. The Congress hereby finds and declares—

"(a) that marine resources, including animal and vegetable life and mineral wealth, constitute a far-reaching and largely untapped asset of immense potential significance to the United States; and

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Appendix B-3—National Sea Grant College and Program Act of 1966—Continued

"(b) that it is in the national interest of the United States to develop the skilled manpower, including scientists, engineers, and technicians, and the facilities and equipment necessary for the exploitation of these resources; and

"(c) that aquaculture, as with agriculture on land, and the gainful use of marine resources can substantially benefit the United States, and ultimately the people of the world, by providing greater economic opportunities, including expanded employment and commerce; the enjoyment and use of our marine resources; new sources of food; and new means for the development of marine resources; and

"(d) that Federal support toward the establishment, development, and operation of programs by sea grant colleges and Federal support of other sea grant programs designed to achieve the gainful use of marine resources, offer the best means of promoting programs toward the goals set forth in clauses (a), (b), and (c), and should be undertaken by the Federal Government; and

"(e) that in view of the importance of achieving the earliest possible institution of significant national activities related to the development of marine resources, it is the purpose of this title to provide for the establishment of a program of sea grant colleges and education, training, and research in the fields of marine science, engineering, and related disciplines.

"GRANTS AND CONTRACTS FOR SEA GRANT COLLEGES AND PROGRAMS

"SEC. 203. (a) The provisions of this title shall be administered by the National Science Foundation (hereafter in this title referred to as the 'Foundation').

"(b)(1) For the purpose of carrying out this title, there is authorized to be appropriated to the Foundation for the fiscal year ending June 30, 1967, not to exceed the sum of $5,000,000, for the fiscal year ending June 30, 1968, not to exceed the sum of $15,000,000, and for each subsequent fiscal year only such sums as the Congress may hereafter specifically authorize by law.

"(2) Amounts appropriated under this title are authorized to remain available until expended.

"MARINE RESOURCES

"SEC. 204. (a) In carrying out the provisions of this title the Foundation shall (1) consult with those experts engaged in pursuits in the various fields related to the development of marine resources and with all departments and agencies of the Federal Government (including the United States Office of Education in all matters relating to education) interested in, or affected by, activities in any such fields, and (2) seek advice and counsel from the National Council on Marine Resources and Engineering Development as provided by section 205 of this title.

"(b) The Foundation shall exercise its authority under this title by—

"(1) initiating and supporting programs at sea grant colleges and other suitable institutes, laboratories, and public or private agencies for the education of participants in the various fields relating to the development of marine resources;

"(2) initiating and supporting necessary research programs in the various fields relating to the development of marine resources, with preference given to research aimed at practices, techniques, and design of equipment applicable to the development of marine resources; and

"(3) encouraging and developing programs consisting of instruction, practical demonstrations, publications, and otherwise, by sea grant colleges and other suit-

Appendix B-3—National Sea Grant College and Program Act of 1966—Continued

able institutes, laboratories, and public or private agencies through marine advisory programs with the object of imparting useful information to persons currently employed or interested in the various fields related to the development of marine resources, the scientific community, and the general public.

"(c) Programs to carry out the purposes of this title shall be accomplished through contracts with, or grants to, suitable public or private institutions of higher education, institutes, laboratories, and public or private agencies which are engaged in, or concerned with, activities in the various fields related to the development of marine resources, for the establishment and operation by them of such programs.

"(d)(1) The total amount of payments in any fiscal year under any grant to or contract with any participant in any program to be carried out by such participant under this title shall not exceed 66⅔ per centum of the total cost of such program. For purposes of computing the amount of the total cost of any such program furnished by any participant in any fiscal year, the Foundation shall include in such computation an amount equal to the reasonable value of any buildings, facilities, equipment, supplies, or services provided by such participant with respect to such program (but not the cost or value of land or of Federal contributions).

"(2) No portion of any payment by the Foundation to any participant in any program to be carried out under this title shall be applied to the purchase or rental of any land or the rental, purchase, construction, preservation, or repair of any building, dock, or vessel.

"(3) The total amount of payments in any fiscal year by the Foundation to participants within any State shall not exceed 15 per centum of the total amount appropriated to the Foundation for the purposes of this title for such fiscal year.

"(e) In allocating funds appropriated in any fiscal year for the purposes of this title the Foundation shall endeavor to achieve maximum participation by sea grant colleges and other suitable institutes, laboratories, and public or private agencies throughout the United States, consistent with the purposes of this title.

"(f) In carrying out its functions under this title, the Foundation shall attempt to support programs in such a manner as to supplement and not duplicate or overlap any existing and related Government activities.

"(g) Except as otherwise provided in this title, the Foundation shall, in carrying out its functions under this title, have the same powers and authority it has under the National Science Foundation Act of 1950 to carry out its functions under that Act.

"(h) The head of each department, agency, or instrumentality of the Federal Government is authorized, upon request of the Foundation, to make available to the Foundation, from time to time, on a reimbursable basis, such personnel, services, and facilities as may be necessary to assist the Foundation in carrying out its functions under this title.

"(i) For the purposes of this title—

"(1) the term 'development of marine resources' means scientific endeavors relating to the marine environment, including, but not limited to, the fields oriented toward the development, conservation, or economic utilization of the physical, chemical, geological, and biological resources of the marine environment; the fields of marine commerce and marine engineering; the fields relating to exploration or research in, the recovery of natural resources from, and the transmission of energy in, the marine environment; the fields of oceanography and oceanology; and the fields with respect to the study of the economic, legal, medical, or sociological problems arising out of the management, use, development, recovery, and control of the natural resources of the marine environment;

Appendix B-3—National Sea Grant College and Program Act of 1966—Continued

"(2) the term 'marine environment' means the oceans; the Continental Shelf of the United States; the Great Lakes; the seabed and subsoil of the submarine areas adjacent to the coasts of the United States to the depth of two hundred meters, or beyond that limit, to where the depths of the superjacent waters admit of the exploitation of the natural resources of the area; the seabed and subsoil of similar submarine areas adjacent to the coasts of islands which comprise United States territory; and the natural resources thereof;

"(3) the term 'sea grant college' means any suitable public or private institution of higher education supported pursuant to the purposes of this title which has major programs devoted to increasing our Nation's utilization of the world's marine resources; and

"(4) the term 'sea grant program' means (A) any activities of education or research related to the development of marine resources supported by the Foundation by contracts with or grants to institutions of higher education either initiating, or developing existing programs in fields related to the purposes of this title, (B) any activities of education or research related to the development of marine resources supported by the Foundation by contracts with or grants to suitable institutes, laboratories, and public or private agencies, and (C) any programs of advisory services oriented towards imparting information in fields related to the development of marine resources supported by the Foundation by contracts with or grants to suitable institutes, laboratories, and public or private agencies.

"ADVISORY FUNCTIONS

"SEC. 205. The National Council on Marine Resources and Engineering Development established by section 3 of title I of this Act shall, as the President may request—

"(1) advise the Foundation with respect to the policies, procedures, and operations of the Foundation in carrying out its functions under this title;

"(2) provide policy guidance to the Foundation with respect to contracts or grants in support of programs conducted pursuant to this title, and make such recommendations thereon to the Foundation as may be appropriate; and

"(3) submit an annual report on its activities and its recommendations under this section to the Speaker of the House of Representatives, the Committee on Merchant Marine and Fisheries of the House of Representatives, the President of the Senate, and the Committee on Labor and Public Welfare of the Senate."

SEC. 2. (a) The Marine Resources and Engineering Development Act of 1966 is amended by striking out the first section and inserting in lieu thereof the following:

"TITLE I—MARINE RESOURCES AND ENGINEERING DEVELOPMENT

"SHORT TITLE

"SECTION 1. This title may be cited as the 'Marine Resources and Engineering Development Act of 1966'."

(b) Such Act is further amended by striking out "this Act" the first place it appears in section 4(a), and also each place it appears in sections 5(a), 8, and 9, and inserting in lieu thereof in each such place "this title".

Appendix B–3—National Sea Grant College and Program Act of 1966—Continued

AMENDMENT

(PUBLIC LAW 90–477, AUGUST 11, 1968)

AN ACT To amend title II of the Marine Resources and Engineering Development Act of 1966

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That title II of the Marine Resources and Engineering Development Act of 1966 is amended as follows:

(1) Section 203(b)(1) of the Marine Resources and Engineering Development Act of 1966 is amended by inserting immediately after "for the fiscal year ending June 30, 1968, not to exceed the sum of $15,000,000," the following: "for the fiscal year ending June 30, 1969, not to exceed the sum of $6,000,000, for the fiscal year ending June 30, 1970, not to exceed the sum of $15,000,000,".

(2) Section 204(d)(1) of the Marine Resources and Engineering Development Act of 1966 is amended by deleting the phrase "in any fiscal year" each time it appears therein.

Appendix B–4—Senate Concurrent Resolution 72—International Decade of Ocean Exploration

Whereas the Congress finds that an unprecedented scientific and technological readiness now exists for exploration of the oceans and their resources;

Whereas accelerated exploration of the nature, extent, and distribution of ocean resources could significantly increase the food, mineral, and energy resources available for the benefit of mankind;

Whereas improved understanding of ocean processes would enhance the protection of life and property against severe storms and other hazards, would further the safety of maritime commerce, would directly contribute to the development of coastal areas of the Nation, would benefit the Nation's fishing and mineral extractive industries, and would contribute to advancement of a broad range of scientific disciplines;

Whereas realization of the full potential of the oceans will require a long-term program of exploration, observation, and study on a world-wide basis, utilizing ships, buoys, aircraft, satellites, undersea submersibles, and other platforms, advanced navigation systems, and expanded data processing and distribution facilities;

Whereas the inherently international character of ocean phenomena has attracted the interest of many nations;

Whereas excellence, experience, and capabilities in marine science and technology are shared by many nations and a broad program of ocean exploration can most effectively and economically be carried out through a cooperative effort by many nations of the world; and

Whereas the United States has begun to explore through the United Nations and other forums international interest in a long-term program of ocean exploration: Now, therefore, be it

Resolved by the Senate of the United States (the House of Representatives concurring) [1], That it is the sense of Congress that the United States should participate in and give full support to an International Decade of Ocean Exploration during the 1970's which would include (1) an expanded national program of exploration in waters close to the shores of the United States, (2) intensified exploration activities

[1] Not acted on by the House during 90th Congress.

Appendix B–4—Senate Concurrent Resolution 72—International Decade of Ocean Exploration—Continued

in waters more distant from the United States, and (3) accelerated development of the capabilities of the United States to explore the oceans and particularly the training and education of needed scientists, engineers, and technicians.

SEC. 2. It is further the sense of Congress that the President should cooperate with other nations in (1) encouraging broad international participation in an International Decade of Ocean Exploration, (2) sharing results and experiences from national ocean exploration programs, (3) planning and coordinating international cooperative projects within the framework of a sustained, long-range international effort to investigate the world's oceans, (4) strengthening and expanding international arrangements for the timely international exchange of oceanographic data, and (5) providing appropriate technical and training assistance and facilities to the developing countries and support to international organizations so they may effectively contribute their share to the International Decade of Ocean Exploration.

SEC. 3. It is further the sense of Congress that the President in his annual report to the Congress on marine science affairs pursuant to Public Law 89–454 should transmit to the Congress a plan setting forth the proposed participation of the United States for the next fiscal year in the International Decade of Ocean Exploration. The plan should contain a statement of the activities to be conducted and specify the department or agency of the Government which would conduct the activity and seek appropriations therefor.

APPENDIX C—ACTIVITIES OF INTERNATIONAL ORGANIZATIONS AND OTHER NATIONS

Appendix C-1—Resolutions Adopted by United Nations General Assembly

A. 2340 (XXII)

Examination of the Question of the Reservation Exclusively for Peaceful Purposes of the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, Underlying the High Seas Beyond the Limits of Present National Jurisdiction, and the Uses of Their Resources in the Interests of Mankind

The General Assembly,

Having considered the item "Examination of the question of the reservation exclusively for peaceful purposes of the seabed and the ocean floor, and the subsoil thereof underlying the high seas beyond the limits of present national jurisdiction, and the uses of their resources in the interests of mankind",

Noting that developing technology is making the seabed and the ocean floor, and the subsoil thereof, accessible and exploitable for scientific, economic, military and other purposes,

Recognizing the common interest of mankind in the seabed and the ocean floor which constitute the major portion of the area of this planet,

Recognizing further that the exploration and use of the seabed and the ocean floor, and the subsoil thereof, as contemplated in the title of the item, should be conducted in accordance with the principles and purposes of the Charter of the United Nations, in the interest of maintaining international peace and security and for the benefit of all mankind,

Mindful of the provisions and practice of the law of the sea relating to this question,

Mindful also of the importance of preserving the seabed and the ocean floor, and the subsoil thereof, as contemplated in the title of the item, from actions and uses which might be detrimental to the common interests of mankind,

Desiring to foster greater international cooperation and coordination in the further peaceful exploration and use of the seabed and the ocean floor, and the subsoil thereof, as contemplated in the title of the item,

Recalling the past and continuing valuable work on questions relating to this matter carried out by the competent organs of the United Nations, the specialized agencies, the International Atomic Energy Agency and other intergovernmental organizations,

Recalling further that surveys are being prepared by the Secretary-General in response to General Assembly resolution 2172 (XXI) of 6 December 1966 and Economic and Social Council resolution 1112 (XL) of 7 March 1966,

1. *Decides* to establish an *ad hoc* Committee to study the peaceful uses of the seabed and the ocean floor beyond the limits of national jurisdiction composed of Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Ceylon, Chile, Czechoslovakia, Ecuador, El Salvador, France, Iceland, India, Italy, Japan, Kenya, Liberia, Libya, Malta, Norway, Pakistan, Peru, Poland, Rumania, Senegal, Somalia, Thailand, the Union of Soviet Socialist Republics, the United Arab Republic, the United Kingdom of Great Britain and Northern Ireland, the United Republic of Tanzania, the United States of America, and Yugoslavia, to study the scope and various aspects of this item;

2. *Requests* the *ad hoc* Committee, in cooperation with the Secretary-General, to prepare, for consideration by the General Assembly at its twenty-third session, a study which would include:

Appendix C–1—Resolutions Adopted by United Nations General Assembly—Continued

(a) a survey of the past and present activities of the United Nations, the specialized agencies, the International Atomic Energy Agency and other inter-governmental bodies with regard to the seabed and the ocean floor, and of existing international agreements concerning these areas;
(b) an account of the scientific, technical, economic, legal, and other aspects of this item;
(c) an indication regarding practical means to promote international cooperation in the exploration, conservation and use of the seabed and the ocean floor, and the subsoil thereof, as contemplated in the title of the item, and of their resources, having regard to the views expressed and suggestions put forward by Member States during the consideration of this item at the twenty-second session of the General Assembly;

3. *Requests* the Secretary-General:
(a) to transmit the text of this resolution to the Governments of all Member States in order to seek their views on the subject;
(b) to transmit to the *ad hoc* Committee the records of the First Committee relating to the discussion of this item;
(c) to render all appropriate assistance to the *ad hoc* Committee, including the submission thereto of the results of the studies being undertaken in pursuance of General Assembly resolution 2172 (XXI) and Economic and Social Council resolution 1112 (XL) and such documentation pertinent to this item as may be provided by the United Nations Educational, Scientific and Cultural Organization and its Inter-governmental Oceanographic Commission, the Inter-governmental Maritime Consultative Organization, the Food and Agriculture Organization of the United Nations, the World Meteorological Organization, the World Health Organization, the International Atomic Energy Agency and other intergovernmental bodies;

4. *Invites* the specialized agencies, the International Atomic Energy Agency, and other intergovernmental bodies to cooperate fully with the *ad hoc* Committee in the implementation of this resolution.

18 December 1967

B. 2467A(XXIII)

Establishment of a Standing Seabed Committee

The General Assembly,

Recalling the item entitled "Examination of the question of the reservation exclusively for peaceful purposes of the sea-bed and the ocean floor, and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction, and the use of their resources in the interests of mankind",

Having in mind its resolution 2340 (XXII) of 18 December 1967 concerned with the problems arising in the area to which the title of the item refers,

Reaffirming the objectives set forth in that resolution,

Taking note with appreciation of the report prepared by the *Ad Hoc* Committee to Study the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction, keeping in mind the views expressed in the course of its work and drawing upon its experience,

Recognizing that it is in the interest of mankind as a whole to favour the exploration and use of the sea-bed and the ocean floor and the subsoil thereof, beyond the limits of national jurisdiction, for peaceful purposes,

Appendix C–1—Resolutions Adopted by United Nations General Assembly—Continued

Considering that it is important to promote international co-operation for the exploration and exploitation of the resources of this area,

Convinced that such exploitation should be carried out for the benefit of mankind as a whole, irrespective of the geographical location of States, taking into account the special interests and needs of the developing countries,

Considering that it is essential to provide, within the United Nations system, a focal point for the elaboration of desirable measures of international co-operation, taking into account alternative actual and potential uses of this area, and for the co-ordination of the activities of international organizations in this regard,

1. *Establishes* a Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction, composed of forty-two States;

2. *Instructs* the Committee:

(a) To study the elaboration of the legal principles and norms which would promote international co-operation in the exploration and use of the sea-bed and the ocean floor and the subsoil thereof beyond the limits of national jurisdiction and to ensure the exploitation of their resources for the benefit of mankind, and the economic and other requirements which such a régime should satisfy in order to meet the interests of humanity as a whole;

(b) To study the ways and means of promoting the exploitation and use of the resources of this area, and of international co-operation to that end, taking into account the foreseeable development of technology and the economic implications of such exploitation and bearing in mind the fact that such exploitation should benefit mankind as a whole;

(c) To review the studies carried out in the field of exploration and research in this area and aimed at intensifying international co-operation and stimulating the exchange and the widest possible dissemination of scientific knowledge on the subject;

(d) To examine proposed measures of co-operation to be adopted by the international community in order to prevent the marine pollution which may result from the exploration and exploitation of the resources of this area;

3. *Also calls upon* the Committee to study further, within the context of the title of the item, and taking into account the studies and international negotiations being undertaken in the field of disarmament, the reservations exclusively for peaceful purposes of the sea-bed and the ocean floor without prejudice to the limits which may be agreed upon in this respect;

4. *Requests* the Committee:

(a) To work in close co-operation with the specialized agencies, the International Atomic Energy Agency and the intergovernmental bodies dealing with the problems referred to in the present resolution, so as to avoid any duplication or overlapping of activities;

(b) To make recommendations to the General Assembly on the questions mentioned in paragraphs 2 and 3 above;

(c) In co-operation with the Secretary-General, to submit to the General Assembly reports on its activities at each subsequent session;

5. *Invites* the specialized agencies, the International Atomic Energy Agency and other inter-governmental bodies including the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization to co-operate fully with the Committee in the implementation of the present resolution.

21 December 1968

Appendix C–1—Resolutions Adopted by United Nations General Assembly—Continued

C. 2467B (XXIII)

Prevention of Pollution

The General Assembly,

Recognizing that it is in the common interest of all nations that the exploration and exploitation of the resources of the sea-bed and the ocean floor, and the subsoil thereof, should be conducted in such a manner as to avoid infringement of the other interests and established rights of nations with respect to the uses of the sea,

Mindful of the threat to the marine environment presented by pollution and other hazardous and harmful effects which might result from exploration and exploitation of the areas under consideration,

Desiring to promote effective measures of prevention and control of such pollution and to allay the serious damage which might be caused to the marine environment and, in particular, to the living marine resources which constitute one of mankind's most valuable food resources,

Recognizing the complex problem of ensuring effective co-ordination in the wide field of environmental pollution and in the more specific area of prevention and control of marine pollution,

Noting with satisfaction the measures being undertaken by the Inter-Governmental Maritime Consultative Organization to prevent and control pollution of the sea by preparing new draft conventions and other instruments for that purpose,

Recalling, in this regard, the progress achieved towards such concerted action by inter-governmental bodies and the establishment, by the Food and Agriculture Organization of the United Nations, the United Nations Educational, Scientific and Cultural Organization and its Intergovernmental Oceanographic Commission, the Inter-Governmental Maritime Consultative Organization and the World Meteorological Organization, of a Joint Group of Experts on the Scientific Aspects of Marine Pollution,

Recalling further the competence and continuing valuable contributions of the other inter-governmental organizations concerned,

1. *Welcomes* the adoption by States of appropriate safeguards against the dangers of pollution and other hazardous and harmful effects that might arise from the exploration and exploitation of the resources of the sea-bed and the ocean floor and the subsoil thereof, beyond the limits of national jurisdiction, notably in the form of concrete measures of international co-operation for the purpose of realizing this aim;

2. *Considers* that in connexion with the elaboration of principles underlying possible future international agreements for the area concerned, a study should be made with a view to clarifying all aspects of protection of the living and other resources of the sea-bed and ocean floor, the superjacent waters and the adjacent coasts against the consequences of pollution and other hazardous and harmful effects arising from various modalities of such exploration and exploitation;

3. *Considers further* that such a study should take into consideration the importance of minimizing interference between the many means by which the wealth of the ocean space may be harvested, and that it should extend to the examination of the circumstances in which measures may be undertaken by States for the protection of the living and other resources of those areas in which pollution detrimental to those resources has occurred or is imminent;

4. *Requests* the Secretary-General, in co-operation with the appropriate and competent body or bodies presently undertaking co-ordinated work in the field of marine pollution control, to undertake the study referred to in paragraphs 2 and 3 above

Appendix C–1—Resolutions Adopted by United Nations General Assembly—Continued

and to submit a report thereon to the General Assembly and the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction.

21 December 1968

D. 2467C (XXIII)

Study of International Machinery

The General Assembly,

Having considered the item entitled "Examination of the question of the reservation exclusively for peaceful purposes of the sea-bed and the ocean floor, and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction, and the use of their resources in the interests of mankind",

Reaffirming that exploration and exploitation of the resources of the sea-bed and ocean floor, and the subsoil thereof, should be carried out for the benefit of mankind as a whole, taking into special consideration the interests and needs of the developing countries,

Recalling that international co-operation in this field is of paramount importance,

Bearing in mind its resolution 2467A (XXIII) establishing the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction, and the mandate entrusted to it,

1. *Requests* the Secretary-General to undertake a study on the question of establishing in due time appropriate international machinery for the promotion of the exploration and exploitation of the resources of this area, and the use of these resources in the interests of mankind, irrespective of the geographical location of States, and taking into special consideration the interests and needs of the developing countries, and to submit a report thereon to the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction for consideration during one of its sessions in 1969;

2. *Calls upon* the Committee to submit a report on this question to the General Assembly at its twenty-fourth session.

21 December 1968

E. 2467D (XXIII)

Expanded Cooperation and an International Decade of Ocean Exploration

The General Assembly,

Convinced that the nations of the world should join together, with due respect for national jurisdiction, in a common long-term programme of exploration of the ocean as a potential source of resources, which should eventually be used for meeting the needs of all mankind with due recognition of those of developing countries and irrespective of the geographical location of States,

Recalling also that in its resolution 2172 (XXI) of 6 December 1966 it requested the Secretary-General to prepare proposals for ensuring the most effective arrangements for an expanded programme of international co-operation to assist in a better understanding of the marine environment through science, and to initiating and strengthening marine education and training programmes,

Recalling further the proposals made by the Secretary-General in his report, pursuant to resolution 2172 (XXI), as well as the various views expressed during the consideration of this subject by the General Assembly at its twenty-third session,

Appendix C-1—Resolutions Adopted by United Nations General Assembly—Continued

Noting that the Bureau and Consultative Council of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization considered the proposed International Decade of Ocean Exploration a useful initiative for broadening and accelerating investigations of the oceans and for strengthening international co-operation,

Endorsing the objectives expressed in Economic and Social Council resolutions 1380 (XLV), 1381 (XLV) and 1382 (XLV) of 2 August 1968 and recalling particularly the invitation to the General Assembly to endorse the concept of a co-ordinated long-term programme of oceanographic research, taking into account such initiatives as the proposal for an International Decade of Ocean Exploration and international programmes already considered, approved and adopted by the Intergovernmental Oceanographic Commission for implementation in co-operation with other specialized agencies,

Aware of the consideration given to the proposal in the *Ad Hoc* Committee to Study the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction, arising from the contribution which the Decade would make to scientific research and exploration of the sea-bed and ocean floor, as an important part of a co-ordinated long-term international programme of oceanographic research,

Seeking to enrich the knowledge of all mankind by encouraging a free flow of scientific information on the oceans to all States,

1. *Welcomes* the concept of an International Decade of Ocean Exploration to be undertaken within the framework of a long-term programme of research and exploration, including scientific research and exploration of the sea-bed and the ocean floor, under the aegis of the United Nations on the understanding that all such activities falling under the national jurisdiction of a State shall be subject to the previous consent of such State, in accordance with international law;

2. *Invites* Member States to formulate proposals for national and international scientific programmes and agreed activities to be undertaken during the Decade with due regard to the interests of developing countries, to transmit these proposals to the United Nations Educational, Scientific and Cultural Organization for the Intergovernmental Oceanographic Commission in time to begin the Decade in 1970, and to embark on such activities as soon as practicable;

3. *Urges* Member States to publish as soon as practicable the results of all activities which they will have undertaken within the framework of the Decade as part of a long-term co-ordinated programme of scientific research and exploration, and at the same time to communicate these results to the Intergovernmental Oceanographic Commission;

4. *Requests* the United Nations Educational, Scientific and Cultural Organization that its Intergovernmental Oceanographic Commission:

(a) Intensify its activities in the scientific field, within its terms of reference and in co-operation with other interested agencies, in particular with regard to co-ordinating the scientific aspects of a long-term and expanded programme of world-wide exploration of the oceans and their resources of which the Decade will be an important element, including international agency programmes, an expanded international exchange of data from national programmes, and international efforts to strengthen the research capabilities of all interested nations with particular regard to the needs of the developing countries;

(b) Co-operate with the Secretary-General in accordance with paragraph 4 of General Assembly resolution 2414 (XXIII) of 17 December 1968 (Resources of the sea) in the preparation of the comprehensive outline of the scope of the long-term programme of oceanographic research of which the Decade will be an important ele-

Appendix C-1—Resolutions Adopted by United Nations General Assembly—Continued

ment, making available its views as to the appropriate relationship between the several international programmes already considered, approved and adopted by the Intergovernmental Oceanographic Commission for implementation, the Decade, and the long-term programme;

(c) Keep the Secretary-General informed of all proposals, programmes and activities of which it is informed in accordance with paragraphs 2 and 3 above together with any comments it may consider appropriate;

(d) Report through appropriate channels to the General Assembly at its twenty-fourth session on progress made in the implementation of the present resolution.

21 December 1968

F. 2413 (XXIII)

Exploitation and conservation of living marine resources

The General Assembly,

Recalling its resolution 2172 (XXI) of 6 December 1966 requesting the Secretary-General to prepare proposals for ensuring the most effective arrangements for an expanded programme of international co-operation to assist in a better understanding of the marine environment through science, and for the development of marine resources, with due regard for the conservation of fish stocks,

Having considered the report entitled "Resources of the sea beyond the continental shelf" prepared by the Secretary-General under Economic and Social Council resolution 1112 (XL) of 7 March 1966 and the report entitled "Marine science and technology: survey and proposals" prepared by the Secretary-General under General Assembly resolution 2172 (XXI),

Recalling Economic and Social Council resolution 1381 (XLV) of 2 August 1968,

Taking into account the valuable and extensive work accomplished and being carried out in this field by the Food and Agriculture Organization of the United Nations and its Committee on Fisheries, and by other specialized agencies and intergovernmental organizations concerned, striving towards an increase in the world's food production,

Deeply concerned that a large proportion of the world's population continues to suffer from malnutrition and notably from lack of protein,

Mindful of the importance of the living resources of the sea as one of mankind's most important food resources,

Realizing the increasing importance of maximizing the sustainable yield of the living marine resources through conservation and rational development,

Aware of the grave danger of the over-exploitation and depletion of these resources, to which the rapid progress in fisheries technology is contributing,

1. *Invites* Governments of Member States to increase international co-operation in the field of development and exploitation of living marine resources outside the limits of national jurisdiction, having regard to the special needs and interests of the developing countries and with particular emphasis on the need for rational exploitation and conservation of fish stocks, taking into account the valuable work of the Food and Agriculture Organization of the United Nations and its Committee on Fisheries and also of regional and other specialized fishery bodies;

2. *Urges* the United Nations specialized agencies and other intergovernmental organizations concerned to take measures for the further improvement of international collaboration, in relation to fisheries development and conservation, and of technical assistance, where requested by developing countries;

3. *Requests* the Secretary-General, in collaboration with the Director-General of the Food and Agriculture Organization of the United Nations and in consultation

Appendix C–1—Resolutions Adopted by United Nations General Assembly—Continued

with Governments of States Members of the United Nations and with other international organizations concerned, to report to the Economic and Social Council at its forty-ninth session on the specific measures which have been taken by Governments of Member States and by the international organizations concerned in implementation of the present resolution, and request the Economic and Social Council to report thereon to the General Assembly at its twenty-fifth session.

17 December 1968

G. 2414 (XXIII)

International co-operation in problems related to the oceans

The General Assembly,

Reaffirming the considerations set forth in its resolution 2172 (XXI) of 6 December 1966,

Considering the growing interest of the world community in problems related to the oceans, as they hold promise of providing a rapidly developing world with increasingly needed resources,

Being aware that the present knowledge of the ocean and its resources and of the marine environment is limited and incomplete,

Recognizing the need for extensive exploration and research in order to develop the wealth of the sea for the benefit of all mankind, irrespective of the geographical location of States, taking into account the special needs and interests of developing countries,

Having given preliminary consideration to the report entitled "Marine science and technology: survey and proposals", prepared by the Secretary-General under General Assembly resolution 2172 (XXI),

Taking into account the comments of the Advisory Committee on the Application of Science and Technology to Development,

Recalling Economic and Social Council resolutions 1380 (XLV), 1381 (XLV) and 1382 (XLV) of 2 August 1968,

Recalling the report of the *Ad Hoc* Committee to Study the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction,

Taking into account the activities in this field at present being carried out by the United Nations, the United Nations Educational, Scientific and Cultural Organization and its Intergovernmental Oceanographic Commission, the Food and Agriculture Organization of the United Nations and its Committee on Fisheries, the World Meteorological Organization and its Panel on Meteorological Aspects of Ocean Affairs, the Inter-Governmental Maritime Consultative Organization, the International Atomic Energy Agency and other specialized agencies, and also intergovernmental organizations, various Governments, universities, scientific and technical institutes and other non-governmental organizations,

1. *Takes note with appreciation* of the report of the Secretary-General entitled "Marine science and technology: survey and proposals";

2. *Requests* the Economic and Social Council to review further this report at its forty-seventh session taking into account such views as may be expressed by Governments of Member States, by the Advisory Committee on the Application of Science and Technology to Development and by the proposed competent organ of the United Nations;

3. *Endorses* the concept of a co-ordinated long-term programme of oceanographic research designed to assist in a better understanding of the marine environment through science and to increase, in the interests of world economic development, the resources available to all the people of the world;

Appendix C–1—Resolutions Adopted by United Nations General Assembly—Continued

4. *Requests* the Secretary-General to present to the Economic and Social Council at its forty-seventh session a comprehensive outline of the scope of this long-term programme taking into account such scientific recommendations as may be formulated by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization within its terms of reference and in co-operation with other interested international organizations;

5. *Recommends* that the United Nations Educational Scientific and Cultural Organization and its Intergovernmental Oceanographic Commission should consider strengthening the existing marine educational and training programmes and initiating new programmes in connexion with the implementation of the long-term programme of oceanographic research;

6. *Recommends* further improvement of international co-operation in relation to fisheries development and conservation, taking into account the important role played by the Food and Agriculture Organization of the United Nations and its Committee on Fisheries as well as the work of regional and other specialized fishery bodies;

7. *Invites* Member States and organizations dealing with marine pollution, especially the Inter-Governmental Maritime Consultative Organization and the International Atomic Energy Agency, to promote the adoption of effective international agreements on prevention and control of marine pollution as may be necessary;

8. *Recognizes* the importance of the meteorological aspects of ocean science and calls upon the World Meteorological Organization to continue its activities in this field, in close co-operation with other interested organizations;

9. *Invites* the Secretary-General, in consultation with the United Nations Development Programme, to consider the possibility of extending technical assistance services to the Governments of Member States which may request them in relation to the development of mineral resources of their continental shelf areas;

10. *Calls upon* the Secretary-General to pursue the task of collecting and disseminating available information regarding the mineral and other resources of the sea-bed and ocean floor beyond the limits of national jurisdiction and techniques appropriate for their development and of providing the assistance which the proposed competent organ of the United Nations may request for the solution of related issues;

11. *Requests* the Secretary-General, in co-operation with the United Nations Educational, Scientific and Cultural Organization and its Intergovernmental Oceanographic Commission, the Food and Agriculture Organization of the United Nations and its Committee on Fisheries, the World Meteorological Organization, the Inter-Governmental Martime Consultative Organization, the International Atomic Energy Agency and other organizations concerned, to report, through appropriate channels, to the Economic and Social Council and to the General Assembly, at its twenty-fifth session, on the progress achieved in the implementation of the present resolution.

17 December 1968

Appendix C–2—Draft Resolutions Submitted and Principles Supported by the United States in the Ad Hoc Seabed Committee

A. U.S. draft resolution containing statement of principles concerning the deep ocean floor

The General Assembly,

Desiring to encourage the exploration, use and development of the deep ocean floor to the fullest extent possible for the benefit and in the interest of all mankind,

Believing that such exploration and use of the deep ocean floor will contribute to international co-operation and understanding,

Convinced that no nation, regardless of geographical location, level of economic development, or technological capability, should be denied the opportunity to participate in the exploration and use of the deep ocean floor,

Conscious of the importance of promoting the general welfare of all peoples, and of furthering scientific study and the conservation of resources,

Reaffirming the traditional freedoms of the high seas under international law,

Recalling its resolution 2340 (XXII) of 18 December 1967,

Commends to States for their guidance the following principles concerning the deep ocean floor:

1. No State may claim or exercise sovereignty or sovereign rights over any part of the deep ocean floor. There shall be no discrimination in the availability of the deep ocean floor for exploration and use by all States and their nationals in accordance with international law;

2. There shall be established, as soon as practicable, internationally agreed arrangements governing the exploitation of resources of the deep ocean floor. These arrangements shall reflect the other principles contained in this Statement of Principles concerning the Deep Ocean Floor and shall include provision for:

(a) The orderly development of resources of the deep ocean floor in a manner reflecting the interest of the international community in the development of these resources;

(b) Conditions conducive to the making of investments necessary for the exploration and exploitation of resources of the deep ocean floor;

(c) Dedication as feasible and practicable of a portion of the value of the resources recovered from the deep ocean floor to international community purposes; and

(d) Accommodation among the commercial and other uses of the deep ocean floor and marine environment;

3. Taking into account the Geneva Convention of 1958 on the Continental Shelf, there shall be established, as soon as practicable, an internationally agreed precise boundary for the deep ocean floor—the sea-bed and subsoil beyond that over which coastal States may exercise sovereign rights for the purpose of exploration and exploitation of its natural resources; exploitation of the natural resources of the ocean floor that occurs prior to establishment of the boundary shall be understood not to prejudice its location, regardless of whether the coastal State considers the exploitation to have occurred on its "continental shelf";

4. States and their nationals shall conduct their activities on the deep ocean floor in accordance with international law, including the Charter of the United Nations, and in the interest of maintaining international peace and security and promoting international co-operation, scientific knowledge, and economic development;

5. In order to further international co-operation in the scientific investigation of the deep ocean floor, States shall:

(a) Disseminate, in a timely fashion, plans for and results of national scientific programmes concerning the deep ocean floor;

Appendix C-2—Draft Resolutions Submitted and Principles Supported by the United States in the Ad Hoc Seabed Committee—Continued

(b) Encourage their nationals to follow similar practices concerning dissemination of such information;

(c) Encourage co-operative scientific activities regarding the deep ocean floor by personnel of different States;

6. In the exploration and use of the deep ocean floor States and their nationals:

(a) Shall have reasonable regard for the interests of other States and their nationals;

(b) Shall avoid unjustifiable interference with the exercise of the freedom of the high seas by other States and their nationals, or with the conservation of the living resources of the seas, and any interference with fundamental scientific research carried out with the intention of open publication;

(c) Shall adopt appropriate safeguards so as to minimize pollution of the seas and disturbance of the existing biological, chemical and physical processes and balances; each State shall provide timely announcement and any necessary amplifying information of any marine activity or experiment planned by it or its nationals that could harmfully interfere with the activities of any other State or its nationals in the exploration and use of the deep ocean floor. A State which has reason to believe that a marine activity or experiment planned by another State or its nationals could harmfully interfere with its activities or those of its nationals in the exploration and use of the deep ocean floor may request consultation concerning the activity or experiment;

7. States and their nationals shall render all possible assistance to one another in the event of accident, distress or emergency arising out of activities on the deep ocean floor.

June 28, 1968

B. U.S. draft resolution on preventing the emplacement of weapons of mass destruction on the sea-bed and ocean floor

The General Assembly,

Desiring that workable arms limitation measures be achieved that will enhance the peace and security of all nations and bring the world nearer to general and complete disarmament,

Requests the Eighteen-Nation Committee on Disarmament to take up the question of arms limitation on the sea-bed and ocean floor with a view to defining those factors vital to a workable, verifiable and effective international agreement which would prevent the use of this new environment for the emplacement of weapons of mass destruction.

June 28, 1968

C. U.S. draft resolution on the International Decade of Ocean Exploration

The General Assembly,

Recalling its concern for ascertaining practical means to promote international co-operation in the exploration, conservation and use of the sea-bed and the ocean floor, and the subsoil thereof, as manifested in its resolution 2340 (XXII),

Recalling as well that in its resolution 2172 (XXI) it requested that the Secretary-General prepare proposals for ensuring the most effective arrangements for an expanded programme of international co-operation to assist in a better understanding of the marine environment through science, and for initiating and strengthening marine education and training programmes,

Appendix C–2—Draft Resolutions Submitted and Principles Supported by the United States in the Ad Hoc Seabed Committee—Continued

Recalling further the proposals made by the Secretary-General in his report (E/4487) pursuant to resolution 2172 (XXI),

Noting that the Bureau and Consultative Council of the Intergovernmental Oceanographic Commission of UNESCO considered the proposed International Decade of Ocean Exploration a useful initiative for broadening and accelerating investigations of the oceans and for strengthening international co-operation,

Noting also the recommendation adopted by the Economic and Social Council on 2 August 1968, inviting the General Assembly to endorse the concept of a co-ordinated long-term programme of oceanographic research, taking into account such initiatives as the proposal for an International Decade of Ocean Exploration and international programmes already considered, approved and adopted by the Intergovernmental Oceanographic Commission for implementation in co-operation with other specialized agencies,

Aware of the consideration given to the proposal in the *Ad Hoc* Committee to Study the Peaceful Uses of the Sea-Bed and the Ocean Floor, arising from the important contribution which the Decade would make to scientific research and exploration of the sea-bed and deep ocean floor,

1. *Welcomes* and commends to Member States the concept of an International Decade of Ocean Exploration to be undertaken within the framework of a long-term programme of research and exploration under the general aegis of the United Nations;

2. *Invites* interested Member States to formulate proposals for national and international scientific programmes and agreed activities to be undertaken during the Decade with due regard to the interests of developing countries, to transmit these proposals to the Intergovernmental Oceanographic Commission, and to begin such activities as soon as practicable;

3. *Urges* Member States to publish as soon as practicable the results of activities which they will have undertaken within the framework of the Decade and at the same time to communicate these results to the Intergovernmental Oceanographic Commission;

4. *Requests* the Intergovernmental Oceanographic Commission:

(a) To further and co-ordinate, in co-operation with other interested agencies, an expanded, accelerated, long-term and sustained programme of world-wide exploration of the oceans and their resources of which the Decade will be an element, including international agency programmes, expanded international exchange of data from national programmes, and international efforts to strengthen the research capabilities of all interested nations;

(b) To report through appropriate channels to the twenty-fourth session of the General Assembly on the progress made in ocean activities undertaken pursuant to this resolution.

August 26, 1968

D. Draft statement of Agreed Principles proposed for submission to the General Assembly and supported by the United States

(1) There is an area of the sea-bed and ocean floor and the subsoil thereof, underlying the high seas, which lies beyond the limits of national jurisdiction (hereinafter described as "this area");

(2) Taking into account relevant dispositions of international law, there should be agreed a precise boundary for this area;

Appendix C–2—Draft Resolutions Submitted and Principles Supported by the United States in the Ad Hoc Seabed Committee—Continued

(3) There should be agreed, as soon as practicable, an international régime governing the exploitation of resources of this area;

(4) No State may claim or exercise sovereign rights over any part of this area, and no part of it is subject to national appropriation by claim of sovereignty, by use or occupation, or by any other means;

(5) Exploration and use of this area shall be carried on for the benefit and in the interests of all mankind, taking into account the special needs of the developing countries;

(6) This area shall be reserved exclusively for peaceful purposes;

(7) Activities in this area shall be conducted in accordance with international law, including the Charter of the United Nations. Activities in this area shall not infringe upon the freedoms of the high seas.

June 28, 1968

Appendix C–3—Resolutions Adopted by the Economic and Social Council

A. 1380 (XLV)

Resources of the sea

The Economic and Social Council,

Having considered the report on "Resources of the sea beyond the continental shelf" prepared by the Secretary-General under Council resolution 1112 (XL) of 7 March 1966,

Realizing fully the importance of the development of the mineral and biological resources of the high seas beyond the continental shelf for the benefit of all mankind and especially of the developing countries,

Being aware of the growing interest of the world community in the problems related to the oceans and their resources as recently illustrated by the adoption of General Assembly resolutions 2172 (XXI) of 6 December 1966 and 2340 (XXII) of 18 December 1967,

Recognizing that further progress in the development and utilization of the marine resources will depend greatly on more specific knowledge being gained on the various characteristics of marine environmental conditions,

Taking into account the view expressed by the Advisory Committee on the Application of Science and Technology to Development,

1. *Takes note* with satisfaction of the report of the Secretary-General, which gives a preliminary picture of the present available knowledge of marine resources beyond the continental shelf, of the techniques used for their development and of related problems;

2. *Recommends* that the report be supplemented by information from other Members of the United Nations and members of the specialized agencies which have a valuable experience in this field, and that thereafter the desirability should be envisaged of issuing it as a United Nations publication;

3. *Invites* the Secretary-General, in co-operation with the various organizations of the United Nations family concerned and in particular with the United Nations Educational, Scientific and Cultural Organization and its Intergovernmental Oceanographic Commission, the Food and Agriculture Organization of the United Nations and its Committee on Fisheries, and the World Meteorological Organization and its Panel on Meteorological Aspects of Ocean Affairs, to continue to promote further systematic investigation aiming at improving the present knowledge of marine environmental conditions;

Appendix C–3—Resolutions Adopted by the Economic and Social Council—Continued

4. *Requests* the Secretary-General to follow closely new developments which may occur in fields of marine mineral resources exploration, evaluation and exploitation beyond the continental shelf and the possible implications thereof, and to report when appropriate to the Council;

5. *Invites* the Food and Agriculture Organization of the United Nations to keep under review developments which may occur in the field of food resources of the sea beyond the continental shelf.

August 2, 1968

B. 1381 (XLV)

Long-range programme for the exploration of the sea

The Economic and Social Council,

Recognizing that the ocean holds promise of becoming a more important source of food and minerals for a rapidly developing world, and that man's knowledge of the ocean and its resources is exceedingly limited,

Having considered the report entitled "Resources of the sea beyond the continental shelf" prepared by the Secretary-General under Council resolution 1112 (XL) and the report entitled "Marine Science and Technology" prepared by him under General Assembly resolution 2172 (XXI) of 6 December 1966,

Taking into account the activities in the fields of research, exploration and description of the oceans at present being undertaken by the United Nations, the United Nations Educational, Scientific and Cultural Organization and its Intergovernmental Oceanographic Commission, the Food and Agriculture Organization of the United Nations and its Committee on Fisheries, the World Meteorological Organization and its Panel on Meteorological Aspects of Ocean Affairs, other specialized agencies and intergovernmental organizations concerned, various governments, universities, scientific and technological institutions, and other non-governmental organizations,

Being aware of the complexity and variability of the marine environment and that scientific investigations of vast scope will be necessary if knowledge of this environment is to increase substantially within a reasonably short period,

Convinced that the nations of the world should join together, with due respect for existing national jurisdictions, in a common long-term programme of exploration of the ocean as a potential source of resources, which could eventually be used for meeting the needs of all mankind, with due recognition of those developing countries,

Noting the endorsement by the Bureau and Consultative Council of the Intergovernmental Oceanographic Commission at its eighth meeting, held in London from 10 to 13 June 1968, of the concept of an expanded accelerated, long-term and sustained programme of exploration of the oceans and their resources, including international programmes, planned and co-ordinated on a world-wide basis, expanded international exchange of data from national programmes, and international efforts to strengthen the research capabilities of all interested nations,

1. *Takes note* with appreciation of the Secretary-General's report entitled "Marine Science and Technology", and of annex V, relating to marine science and its application, to the thirty-fourth report of the Administrative Committee on Co-ordination,

2. *Takes note further* of the steps which are being taken under the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization to give consideration to the future administrative and financial structure of the Commission, as well as to the content of an expanded programme of exploration of the oceans and their resources;

Appendix C-3—Resolutions Adopted by the Economic and Social Council—Continued

3. *Transmits* the Secretary-General's report entitled "Marine Science and Technology" to the General Assembly for further consideration at its twenty-third session;

4. *Invites* the General Assembly to endorse the concept of a co-ordinated long-term programme of oceanographic research designed to increase, in the interests of world economic development, the resources available to all people of the world, taking also into account such initiatives as the proposal for an International Decade of Ocean Exploration and several international programmes already considered, approved and adopted by the International Oceanographic Commission for implementation, in certain cases in co-operation with other specialized agencies.

August 2, 1968

C. 1382 (XLV)

Marine science and technology

The Economic and Social Council,

Considering the importance of marine science and technology for optimum utilization of the world's natural resources,

Bearing in mind that one of the main obstacles to the development of marine science and technology is the shortage of experts and qualified personnel, particularly in the developing countries,

Being convinced that, in order to bring about a better understanding of this subject, knowledge of it must be promoted among the public in general and particularly among young people, who will constitute the technicians and research workers of the future,

Believing that for this purpose it is necessary for the fundamentals of marine science to be inculcated at a pre-university level of education,

Noting with satisfaction the proposals concerning education and training in marine science and technology contained in the report of the Secretary-General,

Requests the United Nations Educational, Scientific and Cultural Organization to study appropriate means of imparting a wider knowledge of the sea and its resources as part of secondary education programmes.

August 2, 1968

Appendix C–4—Breadth of Territorial Seas and Fishing Jurisdictions Claimed by Selected Countries

Country	Territorial sea	Fishing limit	Other
Albania	10 miles	12 miles	
Algeria	12 miles	12 miles	
Argentina		200 miles	200-mile sovereignty claim not affecting freedom of navigation or over flight. Continental Shelf—including sovereignty over superjacent waters.
Australia	3 miles	12 miles	
Belgium	3 miles	12 miles [1]	
Brazil	6 miles	12 miles	
Bulgaria	12 miles	12 miles	
Burma	12 miles	12 miles	
Cambodia	5 miles	12 miles	Continental Shelf to 50 meters including sovereignty over superjacent waters.
Cameroun	18 miles	18 miles	
Canada	3 miles	12 miles	
Ceylon	6 miles	6 miles	Claims right to establish conservation zones within 100 nautical miles of the territorial sea.
Chile	50 kilometers.	200 miles	
China	3 miles	3 miles	
Colombia	12 miles	12 miles	
Congo (Kinshasa)	3 miles	3 miles	
Costa Rica	3 miles		"Specialized conference" over living resources to 200 miles.
Cuba	3 miles	3 miles	
Cyprus	12 miles	12 miles	
Dahomey	12 miles	12 miles	100-mile mineral exploration limit.
Denmark	3 miles	12 miles [1]	
Greenland		12 miles	
Faroe Islands		12 miles	
Dominican Republic	6 miles	12 miles	6-mile contiguous zone including fishing.
Ecuador	200 miles	200 miles	
El Salvador	200 miles	200 miles	
Ethiopia	12 miles	12 miles	
Federal Republic of Germany.	3 miles	12 miles [1]	
Finland	4 miles	4 miles	
France	3 miles	12 miles	
Gabon	12 miles	12 miles	
Gambia	3 miles	3 miles	

See footnote at end of table.

Appendix C–4—Breadth of Territorial Seas and Fishing Jurisdictions Claimed by Selected Countries—Continued

Country	Territorial sea	Fishing limit	Other
Ghana	12 miles	12 miles	Undefined protective areas may be proclaimed seaward of territorial sea, and up to 100 miles seaward of territorial sea may be proclaimed fishing conservation zone.
Greece	6 miles	6 miles	
Guatemala	12 miles	12 miles	
Guinea	130 miles	130 miles	
Guyana	3 miles	3 miles	
Haiti	6 miles	6 miles	
Honduras	12 miles	12 miles	
Iceland	4 miles	12 miles	
India	12 miles	100 miles	
Indonesia	12 miles	12 miles	Archipelago concept baselines.
Iran	12 miles	12 miles	
Iraq	12 miles	12 miles	
Ireland	3 miles	12 miles [1]	
Israel	6 miles	6 miles	
Italy	6 miles	12 miles [1]	
Ivory Coast	6 miles	12 miles	
Jamaica	12 miles		
Japan	3 miles	3 miles	
Jordan	3 miles	3 miles	
Kenya	3 miles	3 miles	
Korea		20 to 200 miles.	Continental Shelf including sovereignty over superjacent waters.
Kuwait	12 miles	12 miles	
Lebanon		6 miles	
Liberia	12 miles	12 miles	
Libya	12 miles	12 miles	
Malagasy Republic	12 miles	12 miles	
Malaysia	3 miles	3 miles	
Maldive Islands	3 miles	6 miles	
Malta	3 miles	3 miles	
Mauritania	12 miles	12 miles	
Mexico	9 miles	12 miles	
Morocco	3 miles	12 miles	Exception—6 miles for Strait of Gibraltar.
Netherlands	3 miles	12 miles [1]	
New Zealand	3 miles	12 miles	

See footnote at end of table.

Appendix C–4—Breadth of Territorial Seas and Fishing Jurisdictions Claimed by Selected Countries—Continued

Country	Territorial sea	Fishing limit	Other
Nicaragua	3 miles	200 miles	Continental Shelf including sovereignty over superjacent waters.
Nigeria	12 miles	12 miles	
Norway	4 miles	12 miles	
Pakistan	12 miles	12 miles	Plus right to establish 100-mile conservation zones. Continental Shelf—including sovereignty over superjacent waters.
Panama	200 miles	200 miles	
Peru	200 miles	200 miles	
Philippines	Archipelago theory.		Waters within straight lines joining appropriate points of outermost islands of the archipelago are considered internal waters; waters between these baselines and the limits described in the Treaty of Paris, Dec. 10, 1898, the United States-Spain Treaty of Nov. 7, 1900, and U.S.-U.K. Treaty of Jan. 2, 1930, are considered to be the territorial sea.
Poland	3 miles	3 miles	
Portugal	No claims	12 miles [1]	
Rumania	12 miles	12 miles	
Saudi Arabia	12 miles	12 miles	
Senegal	12 miles	12 miles	Plus 6-mile contiguous zone.
Sierra Leone	12 miles	12 miles	
Singapore	6 miles	3 miles	
Somali Republic	12 miles	12 miles	
South Africa	6 miles	12 miles	
Spain	6 miles	12 miles [1]	
Sudan	12 miles	12 miles	
Sweden	4 miles	12 miles [1]	
Syria	12 miles	12 miles	Plus 6-mile necessary supervision zone.
Tanzania	12 miles	12 miles	
Thailand	12 miles	12 miles	
Togo	12 miles	12 miles	
Trinidad and Tobago	3 miles	3 miles	

See footnote at end of table.

Appendix C–4—Breadth of Territorial Seas and Fishing Jurisdictions Claimed by Selected Countries—Continued

Country	Territorial sea	Fishing limit	Other
Tunisia	6 miles	12 miles	Territorial sea follows the 50-meter isobath for part of the coast (maximum 65 miles).
Turkey	6 miles	12 miles	
Ukrainian S.S.R.	12 miles	12 miles	
U.S.S.R.	12 miles	12 miles	
United Arab Republic	12 miles	12 miles	
United Kingdom	3 miles	12 miles [1]	
Overseas areas	3 miles	3 miles	
United States of America	3 miles	12 miles	
Uruguay	6 miles	12 miles	
Venezuela	12 miles	12 miles	
Vietnam	3 miles	20 kilometers.	
Yemen	12 miles	12 miles	
Yugoslavia	10 miles	10 miles	

[1] Parties to the European Fisheries Convention wnich provides for the right to establish 3-mile exclusive fishing zone seaward of 3-mile territorial sea plus additional 6-mile fishing zone restricted to the convention nations.

Source: Information available to the National Council on Marine Resources and Engineering Development as of December 1, 1968.

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